nissiles and rockets

THE MISSILE/SPACE WEEKLY

Centaur Heads for Static Testing

CAMAL Knocked from AF's Arsenal . . . .

Drydocks Proposed as Launch Platforms .

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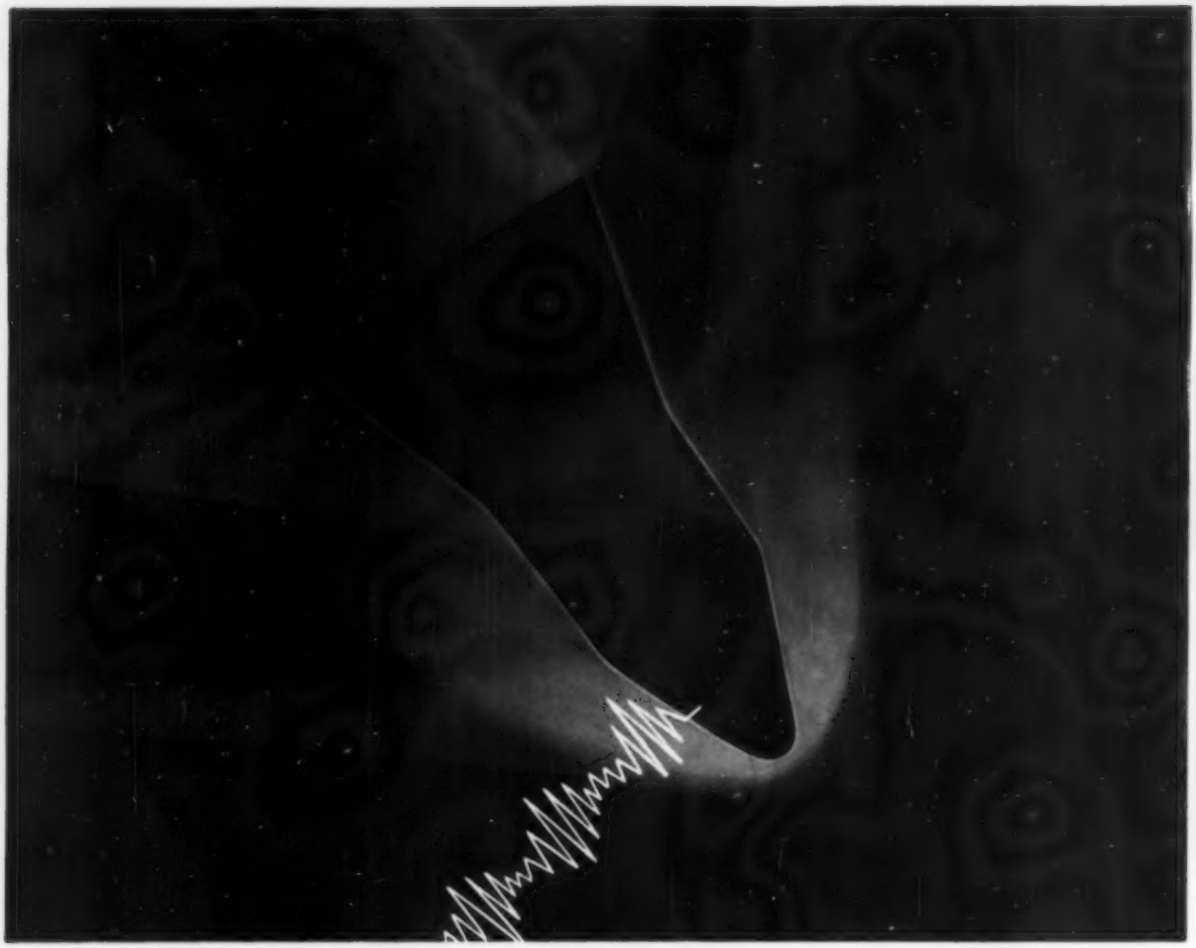

Piercing the plasma sheath...

When ICBMs, satellites or space probes re-enter the earth's atmosphere, frictional heating is so intense that air surrounding the vehicle becomes a "plasma sheath." This acts as a barrier to conventional radio telemetry. AVCO/RAD has developed a Direct Re-entry Telemetry (DRET) system for the U. S. Air Force. The DRET system has been flown on Atlas and Titan ICBMs and has successfully transmitted signals to airborne monitoring equipment. Engineers and scientists at AVCO/RAD are also working on techniques for continuous communications with re-entering manned vehicles, as well as on other conditions in which a plasma barrier exists and where signal penetration is required.

Airborne re-entry tracking team of Avco's RAD Division monitor an Avco Mark 4 re-entry vehicle launched by Titan ICBM.

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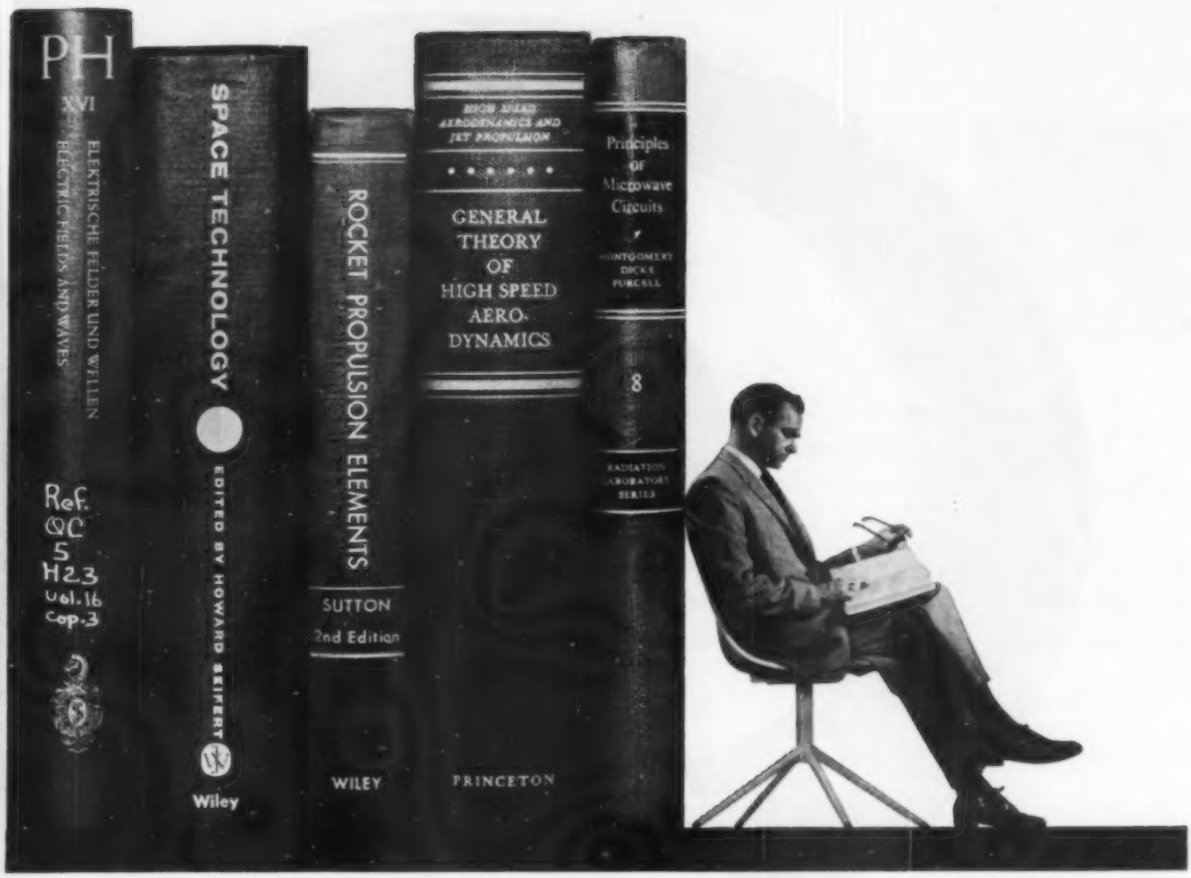

scientists and engineers in a unique leadership role

The frontiers of space science and technology are being expanded at Aerospace Corporation. The scientists and engineers of this leadership organization are the critical civilian link uniting government and the scientific-industrial team developing space systems and advanced ballistic missiles. In providing broad scientific and technical leadership to every element of this team, they are engaged in a balanced program of activities spanning the spectrum from basic research and forward planning through general systems engineering. Included in the latter are technical supervision, integration and review of the engineering, development and test operations of industry to the extent necessary to assure achievement of system concept and objectives in an economical and timely manner. These people are privileged to view both the state-of-the-art and system development in their totality. Now more men of superior ability are needed: highly motivated scientists and engineers with demonstrated achievement, maturity, and judgment, beyond the norm. Such men are urged to contact Aerospace Corporation, Room 105, P. O. Box 95081, Los Angeles 45, California.

Organized in the public interest and dedicated to providing objective leadership in the advancement and application of space science and technology for the United States Government.

AEROSPACE CORPORATION

Said J. Stefan and L. Boltzmann: *"The total radiation from a black body is proportional to the fourth power of the absolute temperature of the black body."*

Radiation is usually associated with high temperatures. Yet very cold bodies emit a radiation which can be highly significant in missile and space applications. The problem faced by infrared scientists, trying to detect variations in radiation from low temperature atmospheres, can be likened to detecting a one-foot cube of ice from a distance of five miles.

Lockheed Missiles and Space Division scientists are deeply engaged in studying the problems of infrared emission from the earth and its atmosphere, as seen from orbital altitudes. Although the earth resembles a black body at 300° Kelvin, the emission from its atmosphere, under some circumstances, is much colder. To make measurements under these circumstances, Lockheed has evolved radiometric equipment with one of the most sensitive detection systems yet conceived.

Scientists and engineers must also take careful measurements of a potential employer. Lockheed Missiles and Space Division in Sunnyvale and Palo Alto, California, on the beautiful San Francisco Peninsula, invites this close scrutiny. As Systems Manager for the DISCOVERER and MIDAS satellites and the POLARIS FBM, Lockheed preeminence in Missiles and Space creates positions in many disciplines for outstanding engineers and scientists.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-13C, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 8, Number 17 April 24, 1961

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Published each Monday with the exception of the last Monday in December by American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Washington 5, D.C. Cable Address: AMERAV.

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Printed at Judd & Detweiler, Inc., Washington, D.C. Second class postage paid at Washington, D.C. Copyright 1961, American Aviation Publications, Inc.

Subscription rates: U.S. Canada and Postal Union nations—1 year, $5.00; 2 years, $8.00; 3 years, $10.00. Foreign—1 year, $10.00; 2 years, $18.00; 3 years, $26.00. Single Copy rate—$.50. Subscriptions are solicited only from persons with identifiable commercial or professional interests in the missile/space industry. Subscription orders and changes of address should be referred to Circulation Fulfillment Mgr. M/R, 1001 Vermont Ave., N.W., Washington 5, D.C. Please allow 4 weeks for change to become effective and enclose recent address label if possible.

THE COVER

NASA's first Centaur spacecraft test vehicle is hoisted from dock at Convair's San Diego plant en route to static testing at nearby Sycamore Canyon.

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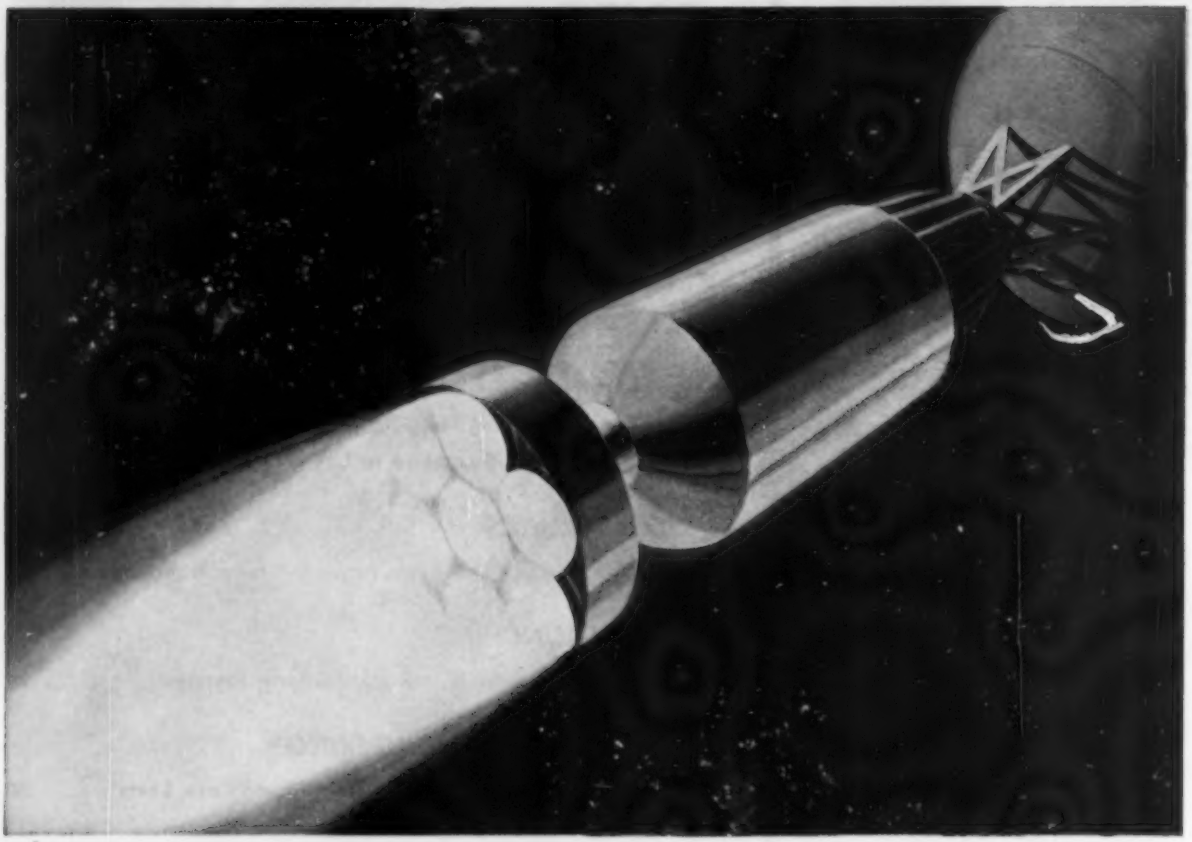
NUCLEAR ROCKET PROPULSION AT AEROJET-GENERAL



Nuclear rockets, with a performance capability nearly twice that of the highest-specific-impulse chemical rockets, have been of major interest to Aerojet-General for several years.

Exploratory studies were initiated by Aerojet in 1955 to ascertain the feasibility of nuclear rockets, and the technical advances required to develop a successful nuclear propulsion system were determined. This work at Aerojet has undergone continuous expansion under government and company sponsored programs. Included are: preliminary design of engines and vehicles, simulated nuclear engine tests, radiation hazards research, analog computer system design (to simulate nuclear rocket operation), nuclear test facility construction, and the design, development, testing, and manufacture of reactors.

These programs have resulted in significant progress toward the development of a practical and reliable nuclear propulsion system. They are based on Aerojet's combined experience in liquid and solid propellant rocketry, nuclear technology, and cryogenics—experience which ensures that the challenge of a new era in propulsion can, and will, be met.

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The Countdown

WASHINGTON

Is Saturn Already Outclassed?

Saturn—billed as the white hope of the nation's lagging space program—already appears to have been dwarfed by the Soviets. COUNTDOWN is told that a high-level analysis of the manned orbital flight April 12 indicates strongly that the total weight placed in orbit was between 25,000 and 30,000 lbs. This is 25 to 50% more than the *Saturn C-1* will be able to loft into orbit in its first scheduled flights in 1964. With such a capability now, the Russians could have boosters in the multimillion-pound-thrust *Nova* class by 1964—making the "Booster Gap" even wider.

A Military Wedge for Space Dollars

The secret Gardner Report on the military uses of space is expected to be used by the Air Force as a powerful wedge for obtaining more money for military spacecraft in the FY '62 budget. At present, the Kennedy defense budget contains no significant funding for such offensive and defensive military spacecraft as have been advocated by Air Force officials.

Titan I and Titan II Coming Up

The Air Force now is planning its first *Titan I* launching from a silo in May. The launching was delayed by an unexplained explosion in the *Titan* test silo at Vandenberg AFB last year. The first *Titan II* launching is now scheduled at Cape Canaveral in November.

Eagle Re-examined

The Navy is trying to decide whether it should make another fight to revive the *Eagle* air-to-air missile or give the program a permanent burial. One key question: Can *Eagle* be usefully employed with existing aircraft?

Pentagon Direct Line

Offsetting rather mild complaints that the new National Aeronautic and Space Council is heavily represented on the civilian side, Council Executive Secretary Edward Welsh is letting it be known that he already is establishing direct liaison with the R&D chiefs of the Army, Navy and Air Force. Welsh says the council staff wants to be informed of all impending major decisions affecting space before they reach the Secretary level.

Samos Fadeout

Next step in the Kennedy Administration's campaign to hush up all information about the *Samos* TV reconnaissance satellite program probably will be to drop a secrecy cloak on all future launchings from PMR's Pt. Arguello. Information from the first R&D *Samos* is understood to be of higher quality than that obtained in U-2 overflights.

End of a Committee

The famed Von Neuman Committee which gave the country the great push that launched the first crash programs to develop ICBM's is no more. The Pentagon has dropped the Ballistic Missile Advisory Committee, as it had come to be called. However, some of its members will be retained as consultants. The move was in line with the Administration drive to reduce the number of government committees.

INDUSTRY

Joshua ICBM Program Under Way

A $100,000 contract to Marquardt confirms the existence of a secret Air Force project aimed at eventual development of a lightweight ICBM. Work on the program—known as *Joshua*—is under way at Edwards AFB Rocket Test Agency. Marquardt will design and fabricate fuel injectors for full and sub-scale testing.

Army To Buy Drop-Boost Test Missiles

The Army is expected soon to award a contract to Convair-Ft. Worth for nine drop boost missiles to be used in a test program for the *Pershing*. The solid-propellant missiles will be dropped from an aircraft, then accelerated to the impact speed of the *Pershing* to test components.

R&D Intelligence

Qualification test firings with practice versions of the nuclear-tipped *Falcon* GAR 11 will be held this summer at Tyndall AFB, Fla., to determine whether it will be bought by NORAD for F-102 interceptors. . . . B.F. Goodrich Aviation Products has a new solid propellant—C-123—composed of Nitro C-Rubber and Hycar synthetic rubber mixed with high-energy compounds. Company claims C-123 has a 15 lb./sec increase in specific impulse over present rubber-based fuels, as well as being lighter in weight.

More Army and Navy Missile Money

Kennedy add-ons to the FY '62 defense budget include $25.3 million for developing a new armored recon/assault vehicle to carry *Shillelagh* and $28.4 million to speed development of the *Mauler* tactical air defense missile. . . . *Polaris* will receive $123.4 million of the $133.4 million added to Navy missile procurement. The remaining $10 million goes into buying 1000 *Bullpups*.

Thought of the Week

From Avco Vice President C. S. Irvine: "I am fully convinced that in 1970, the world will be heading toward all-out democracy and all that it stands for—or it will be going down the road of enslavement and communism."

INTERNATIONAL

Water on the Moon?

British astronomer Zdenek Kopal is reviving the idea that astronauts may find water on the moon—perhaps in subsurface glaciers. Kopal believes upheavals from ice might be the reason for "domes" observed in large numbers in the lunar crust.

Overseas Pipeline

Chancellor Adenauer is now saying that Germany is forbidden to build rockets under the World War II surrender terms—apparently in explanation for holding up the joint European Space Launcher plan. . . . First meeting for the European Preparatory Commission for Space Research (COPERS) will take place May 16 at The Hague. . . . Why some people read *Pravda:* In the March 26, 1961, issue (17 days before Yuri Gagarin's flight) Soviet Academician N. Sisakyan is quoted as saying "tremendous amounts of experimental data" have been obtained which testify to the possibility of manned space flight "right now."

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The Missile/Space Week

An Orbital MA-3 Shot?

In an obvious reaction to the Soviet manned orbital flight, an orbital *Mercury* capsule flight is under consideration for the third *Mercury Atlas* launching *(MA-3)*.

The *MA-3* flight may take place this week. The National Aeronautics and Space Administration will decide a short time before launching whether to make the trajectory a single orbit or immediate re-entry after orbital injection.

Meanwhile, plans are going ahead for the manned *Redstone* flight *(MR-3)*, which will take place soon after *Little Joe 7*, scheduled from Wallops Island, Va., last weekend.

The tentative plans are for one *Mercury* flight from Cape Canaveral this week. If the *MA-3* is flown as planned this week, *MR-3* will lay over until the week of May 1.

However, if there is delay for any reason on *MA-3*, the manned *Redstone* launch is to take place on the previously scheduled date of April 28.

All of the immediate *Mercury* launch plans depend somewhat on the success of *Little Joe 7*, a final qualification of the *Mercury* escape system.

The new *Little Joe* was to be largely a repeat of the *Little Joe 6* flight March 18, using the same capsule after repairs at the McDonnell Aircraft plant.

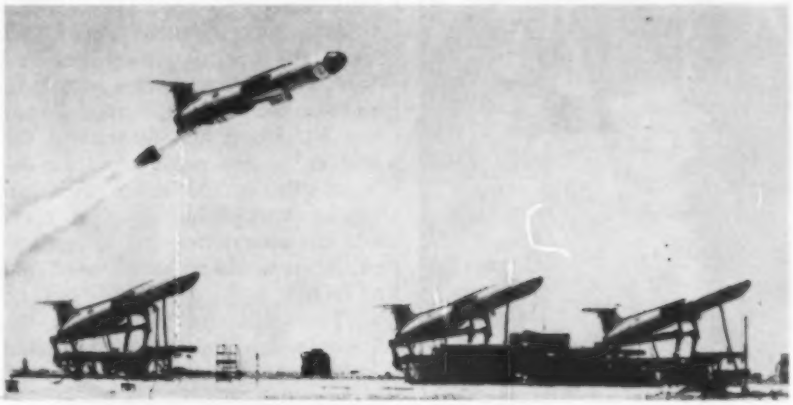
However, the capsule landing bag was not attached because air-drop tests have qualified it sufficiently.

The previous *Little Joe* failed to test the escape system under maximum air loading because the escape rocket fired prematurely. Wiring changes were made for greater assurance that the maneuver will take place on time.

The *Little Joe* was programed to burn out in about 30 sec., with the escape sequence scheduled for 3 sec. later at about 35,000 ft.

The escape tower was to be jettisoned about 1 min. after launch at the peak altitude of 45,000 ft.—about 6 miles offshore.

Escape maneuver involves four steps: (1) separation of capsule from vehicle, (2) firing of the 60,000-lb.-thrust escape rocket, (3) separation of the burned-out escape rocket and tower from the capsule and (4) deploying parachutes.



Multiple-Launching Maces

MACE "A" TACTICAL MISSILE takes off as three sister birds await immediate follow-up firing. The system, being set up for the Air Force in Europe, will fire four of the Martin missiles in less time than it has taken to fire one. *See p. 10.*

Shots of the Week:

At Eglin AFB: Three Air Force *Bomarc B* missiles sped to targets over the Gulf of Mexico and scored two out of three hits. One intercepted and destroyed a *Regulus* target missile launched from down the coast. The second, aimed at a RB47 drone bomber, malfunctioned and dropped into the sea. The third shot downed a target flying at 35,000 feet, 230 miles from its launch site.

At Wallops Island: A bright orange sodium cloud was emitted from a NASA *Nike-Asp* rocket to study high-altitude wind patterns. The test was made in conjunction with similar tests at the Island of Sardinia by the Italian Research Committee.

On March 14, an *Aerobee* research rocket failed after 52 seconds of flight when one of its solenoid-operated cold gas valves malfunctioned.

Saturn Hardware Run

The *Saturn* barge Palaemon is wending its way to Cape Canaveral from Huntsville on a trial run.

Two pieces of *Saturn* hardware—a booster weight simulator and an inert third stage—are on the 1200-ton vessel. The third stage will be left at the Cape for the first *Saturn* launch later this year.

Objectives of the trial are to check out the stage loading and unloading techniques, environmental control and observe the stresses to which the rocket units will be subjected.

B-70 Cut Defended Again

Defense Secretary Robert S. McNamara again backed up the decision made by President Kennedy to cut the B-70 program.

McNamara told a Senate Appropriations committee that the B-70 was cut because it couldn't carry the latest *Hound Dog* or *Skybolt* missiles, it would fly only at subsonic speed in low-altitude attack and "does not lend itself to airborne alert measures."

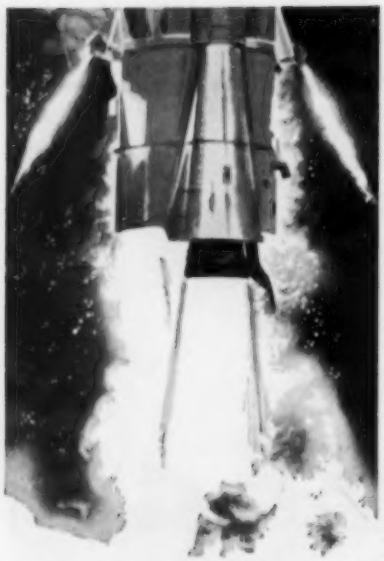
He added that cancellation had been considered, but that since $800 million had already been invested in the program it was considered more beneficial to add another $500 million. Some $220 million has been budgeted for the next fiscal year.

DOD Defends Contractors

The Department of Defense "took up" for its contractors last week and said it opposed setting an overall patent policy which would require taking title to all inventions perfected under a federal contract.

Such a policy would seriously disrupt military R&D programs, G. C.

(Continued on page 10)



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Missile/Space Week

(Continued from page 9)

Bannerman, Deputy Assistant Defense Secretary for procurement, told a Senate subcommittee. Since DOD selects the researcher most advanced in his field, such a policy would make him lose the very commercial advantage which led him to start in the field in the first place. And the defense effort would suffer since advanced work being done in commercial laboratories and design departments would no longer be offered to DOD.

Two bills are pending in the Senate which would reserve to the government titles of all inventions underwritten by public contracts.

Salvoes of Maces

The Martin Co. is installing a new rapid-fire multiple launch system for *Mace* missiles at bases in Europe.

The system, developed by Martin with Goodyear Aircraft Corp., will allow all *Mace "A"* missiles to be fired in salvoes, and cut down the number of crew members required. Countdown for four missiles can be held almost simultaneously under the new operation.

The tactical missile can use either nuclear or conventional warheads.

BAMBI Studies Pressed

Two study contracts valued at about $3 million each have been awarded by the Air Force to investigate the BAMBI concept of ballistic missile defense. Convair and Space Technology Laboratories were recipients.

The studies involve development of a system for orbiting a number of defense satellites. Convair recently finished another study on a space-based missile defense called SPAD.

Adding Pad at Arguello

The Point Arguello Navy missile facility will build a multi-purpose launch pad for high-altitude research rockets.

The pad will be able to handle vehicles with up to 150,000 lbs. thrust. The Navy said it decided to centralize launch operations to save costs because of the increasing number of small rocket launches from the point.

The contract will be awarded about mid-May when bids are opened.

Checking Deadly Genies

AF PILOT makes required preflight inspection of nuclear-tipped Douglas Genie air-to-air rockets on F-101B Voodoo jet fighter. Genie has been operational with Air Defense Command since 1957.

Near-Perfect Recovery

A reliability of .99985 in the Project *Mercury* capsule recovery system was achieved during an 18-month test program.

Tests included some 83 operations, both flights and drops of the capsule over the Salton Sea near Westmoreland, Calif.

The full-scale engineering models of the capsule were launched from a C-130 transport at 30,000 feet and successfully landed by Radioplane's ringsail-type parachute at a rate of 30 fps. Radioplane's system also was proven in *Little Joe, Big Joe* and *Atlas* firings.

Webb Now Stockless

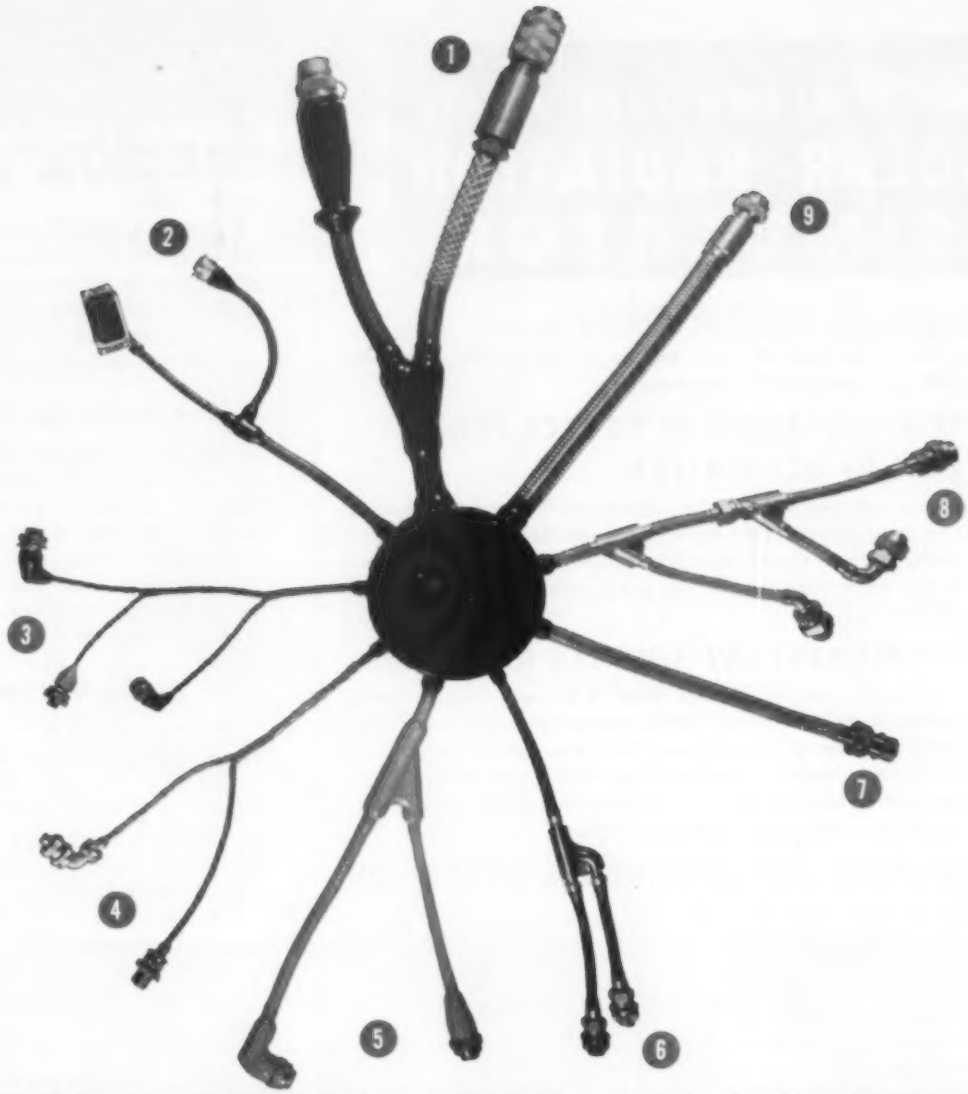
NASA Administrator James E. Webb sold 2248 shares of McDonnell Aircraft common stock during March, reducing his holdings to zero, the Securities and Exchange Commission reported.

Party for Von Karman

Dr. Theodore von Karman, free world's senior statesman of the aerospace sciences, will be honored on his .80th birthday by a symposium sponsored by the Air Force Office of Scientific Research.

More than 37 organizations,

(Continued on page 12)



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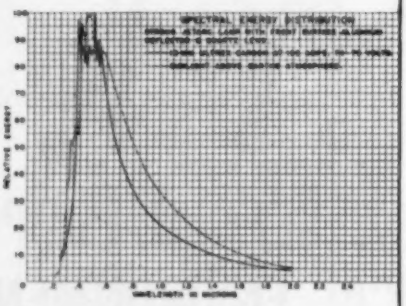

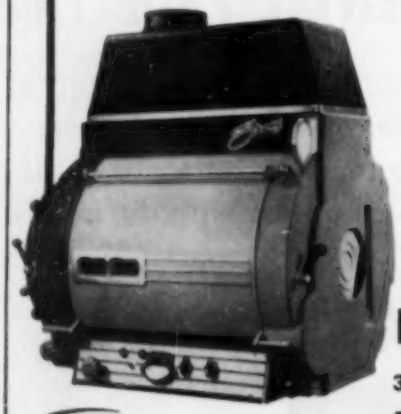

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Missile/Space Week

(Continued from page 10)

headed by the Institute of the Aerospace Sciences, are cooperating in the event to be held May 11 in Washington, D.C.

Dr. von Karman is chairman of the Advisory Group for Aeronautical Research and Development (AGARD) of NATO and honorary president of the International Council of the Aeronautical Sciences.

Helium Money Cut Back

The House Appropriations Committee has slashed $25 million a year from the maximum amount the Interior Dept. can spend for helium conservation. The gas is used in low-temperature research studies and to force propellants from fuel tanks into rocket engines.

AT&T Pushes TV Plans

Commercial transatlantic telephone and television is possible within three to four years, the American Telephone & Telegraph Co. has said.

AT&T has asked the FCC for permission to fire an initial experimental satellite within a year.

The company has begun construction on an experimental space communications ground station in western Maine. Bell Telephone Laboratories will set up a huge rotating antenna, 177 feet long and 94 feet high, to beam signals to the satellite.

Chamber Hits Stoppages

Labor unions averaged one work stoppage every two days at 21 missile bases under construction during the eight-month period ending last February, the U. S. Chamber of Commerce reported.

The Chamber recommended that Congress deny the unions' request to loosen Taft-Hartley law provisions against secondary boycotts.

Correction

The Thiokol Chemical Corp. bid on the NASA-AEC Nerva nuclear engine was filed by the company's Nuclear Development center at Parsippany, N.J. M/R reported erroneously on April 10 that the bid was filed by Thiokol's Reaction Motors Division.

Circle No. 11 on Subscriber Service Card

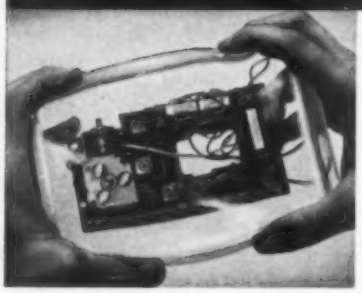
200 miles down the Atlantic Range, General Electric silicone rubber will help keep him afloat

Sixteen and a half minutes after its first manned launching, NASA's blunt-nosed Mercury spacecraft will paradrop into the Atlantic Ocean.

Here it will float like a buoy marker to await recovery. To help protect the first American astronaut, the Mercury spacecraft is completely sealed with General Electric RTV silicone rubber — the new liquid rubber designed to keep the spacecraft air and water tight even after being subjected to the temperature extremes encountered during take-off, flight and re-entry.

McDonnell Aircraft Corporation, prime contractor for the Mercury spacecraft, applies RTV around rivets and bolts wherever structural material, requiring sealing, overlaps or butts together. Able to cure at room temperature, versatile General Electric RTV silicone rubber has found a wide range of uses in missiles and ground support equipment.

G-E SILICONE RUBBER FINDS MANY USES IN MISSILES AND SPACE VEHICLES



Potting and encapsulating materials protect delicate electronic parts. Clear LTV, shown above, is transparent even in sections several inches thick. RTV liquid silicone rubber encapsulants and clear LTV all exhibit excellent electrical properties, resist shock, vibration, ozone, plus corona and other environmental hazards.

Missile wiring harness, above, is from the Titan propulsion system. G-E silicone rubber wire insulation maintains good electrical properties over wide temperature extremes. Jacketing of high-strength silicone rubber, plus breakouts and junctions molded from RTV were chosen for their insulating properties, resistance to temperature extremes and stability in storage.

Silicone rubber gaskets and seals give long life, heat resistance, and low temperature flexibility in many missiles and space vehicles. Applications range from nose cone gaskets to tiny Seelskrews and Hexseals, by Automatic and Precision Mfg. Company, which combine fasteners with silicone rubber seals for easy assembly.

For full information on General Electric RTV silicone rubber, clear LTV silicone compound, and fabricated silicone rubber parts, write: General Electric Company, Silicone Products Dept., Section 0444, Waterford, New York.

GENERAL ELECTRIC

Circle No. 2 on Subscriber Service Card

ANP Decision Knocks CAMAL from A

Kennedy and McNamara argue that plane would have no military value, but apparently have no plans for a strategic substitute

THE AIR FORCE is being forced to revamp its Missile Age strategic planning by the Kennedy Administration decision to kill development of a nuclear-powered aircraft.

The most significant and far-reaching result of the Kennedy decision is the removal from the Air Force's future arsenal of the most mobile and versatile missile carrier of the 1960's—the so-called CAMAL bomber.

Despite Defense Secretary Robert McNamara's protestation that there is "no specific military requirement" for a nuclear-powered aircraft, many Air Force strategists for years have regarded such planes—loaded with *Skybolts*—as:

—A highly invulnerable missile carrier that could be placed on patrol somewhere in the sky around the perimeter of the Soviet Union, but beyond the reach of the Soviet defenses like *Polaris* submarines on patrol in the sea.

—A low-level penetration bomber that could be employed after the initial strikes of a nuclear war for vital reconnaissance and for seeking out and destroying surviving forces with bombs or air-launched missiles.

Together these capabilities made up the Air Force concept of the CAMAL—the continuously airborne missile launcher and low-level penetration bomber system.

In killing CAMAL, the Kennedy Administration appears to have made no provision for performing these missions in the 1960's.

• **"No military value"**—The President gave as his reason for killing the nuclear-powered aircraft program that "nearly 15 years and about $1 billion have been devoted to (it), but the possibility of achieving a militarily useful aircraft in the foreseeable future is still very remote."

McNamara complained that neither of the two types of nuclear-powered aircraft engines under development "holds any great promise as a practical propulsion unit in the foreseeable future." He said all nuclear-powered aircraft would be very large—"gross take-off weight and landing weight would be in the order of a half million pounds at least." He also added:

"While it is true that with an even larger effort some kind of nuclear-powered flight could have been accomplished by now, the aircraft involved would have had little or no military value. It would almost inevitably have been subsonic and limited to an altitude of 35,000 feet."

Neither Kennedy nor McNamara mentioned CAMAL.

Much of this is difficult to reconcile either with what is known of the current program or with recent history.

The nuclear-powered aircraft program has been plagued for years with a series of stoppages, changes and revisions of requirements and specifications.

Some officials have insisted that a nuclear-powered aircraft would be useless unless it were supersonic. Others have argued that the important thing was to get any kind of nuclear aircraft quickly.

Between these two points have stood the Air Force strategists who have called for a relatively fast CAMAL bomber at earliest possible date.

The nuclear-powered aircraft program which Kennedy killed was designed to meet criteria laid down in the late 1950's. At that time the Air Force was told by the Defense Department to develop a nuclear plane capable of flying at a speed of about Mach .8 at about a 35,000-foot ceiling. Its nuclear core was to have a life of about 1000 hours. The plane would have a gross weight of about 500,000 pounds—not, as McNamara implied, a startling amount but about the gross weight of a new B-52. The plane's airframe, known as NX-2, was being built by Convair. First flights were scheduled for 1965.

Such a plane would be very acceptable to the advocates of the CAMAL bomber. A force of CAMAL's could have been deployed in the late 1960's. Moreover, by then the bomber would have been made much more effective by the expected extension in the 1000-mile range of *Skybolt*.

Therefore, Kennedy and McNamara were criticizing the nuclear plane under development for being what it was designed to be. Nor did they bother to mention in their public remarks precisely what that was.

The new Kennedy defense budget vests the nation's nuclear deterrent power in the second half of the 1960's in the fixed *Atlas*, *Titan* and *Minuteman* bases, the mobile *Polaris* submarines and the mobile *Skybolt* launched from B-52 jet bombers.

But all of these systems with the exception of *Skybolt* bombers have a common failing: They must attack preplanned targets. Otherwise, they are shooting blindly.

Only the *Skybolt* bombers can perform the necessary reconnaissance to determine what enemy targets were missed or seek out mobile enemy targets. However, this boon would be short-lived.

In the first place, only B-52's that were on air or ground alert would have any reasonable chance of survival. Secondly, expiration of airborne refueling could be expected to ground all or almost all of them within 12 to 36 hours.

By then, any U.S. reconnaissance satellites, in their predictable orbits would certainly have been destroyed. Tactical bombers would be smashed or grounded for lack of fuel. For the most part, U.S. surviving strategic forces would be fighting with little or no re-

Cost Alternatives

The cost of completing development of a nuclear-powered aircraft would depend on whether work were continued on both the Pratt & Whitney indirect-cycle engine and the GE direct-cycle engine or a choice were made.

Here is how the cost is estimated in both cases:

FY '51 to present

$508 million (Air Force)
$472 million (AEC)

$980 million (Total to present)

***$690 million** (AEC and Air Force—one engine through FY '67 including two years of flight tests)*

***$1270 million** (AEC and Air Force—both engines through FY '67 including two years of flight tests)*

m AF Arsenal

by James Baar

connaissance at all. They would be fighting blind.

Both President Kennedy and McNamara, in chopping off CAMAL and sharply cutting back the B-70 Mach 3 bomber which many considered a partly acceptable substitute, indirectly conceded there may be a need for something to take CAMAL's place.

• **Unhappy dilemma**—Kennedy told Congress in his defense message: "We should also explore the possibility of developing a manned bomber system specifically designed to operate in an environment in which both sides have large ICBM forces."

McNamara said a week later: "We plan to explore the possibility of developing other manned systems better adapted to an operational environment in which both sides have large ICBM forces."

However, so far the modestly-funded *Dyna-Soar* and the possibility of manned spacecraft developing from it is the only new manned system with a current R&D program of any size. Nor has the Kennedy Administration so far shown much inclination to accelerate *Dyna-Soar* or other advanced aerospace systems being proposed by the Air Force.

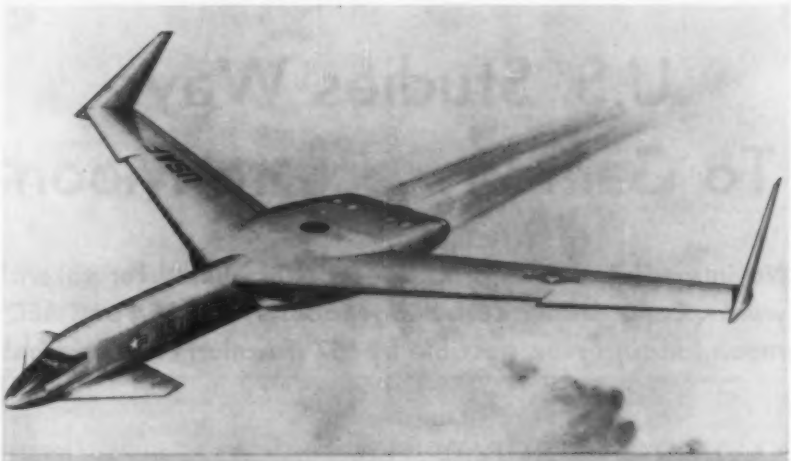
The Kennedy defense budget added $30 million to the *Dyna-Soar* budget—about one third of the amount sought. The new defense budget added only $132 million for unidentified advanced "space research and other projects." The *Samos* reconnaissance satellite program alone could have obsorbed most of it.

Thus the Air Force appears to be caught in an unhappy dilemma.

On one hand, the nuclear-powered aircraft program has been handed to the AEC, where it is being cannabalized for other programs and the remains buried. At the same time, B-70 has been reduced to an R&D insurance policy.

On the other hand, the Administration has so far failed to invest high-priority funds in advanced military space programs including manned spacecraft.

Somehow, with these prospects in view, the Air Force must revamp its strategy to fight a nuclear war in the late 60's. ⌗



'Fallout' from ANP Effort

The 14-year, $1-billion aircraft nuclear program has resulted in a long series of contributions to the field of reactor technology in general. Many of these contributions are being put to use today in the development of nucelar-powered rockets and other missile and space programs. The popular implication that the ANP program has been an extravagant waste is not founded on fact from the standpoint of "fallout" contributions alone. Some samples:

SIZE—The bulky and very heavy nuclear reactors designed for land or shipboard use have been greatly reduced in size and weight. Sea and land-based reactors weigh between 500 and 1000 tons. Reactors designed for aircraft have been reduced in weight to about 100 tons.

SHIELDING—Great quantities of data were collected in shielding experiments. Much of this is directly applicable to the design of nuclear-powered spacecraft and manned spacecraft that must pass through the earth's radiation belts as well as protect their occupants from other radiation hazards in space travel.

METALLURGY—The ANP program claims credit for such developments as a new nickel-molybdenum alloy that increases the operating life of reactors; new technology in the field of high-temperature liquid metal pumps, seals, heat exchangers and instrumentation; new corrosion data on various alloys with lithium, sodium, sodium potassium, lead, bismuth and various fused salts; techniques for fabricating large components of beryllium.

FUEL ELEMENTS—The ANP program developed the metallic dispersion fuel element now widely used in other reactors. Great refinements were made in the use of ceramics. Considerable work was accomplished in developing advanced manufacturing techniques. Development of the homogenous BeO-UO_2 fuel element which is expected to have wide application was started.

REACTOR THEORY—Much information was made available on calculational methods. One technique of reactor analysis that was introduced was the so-called C-5 program. Another was the "Multi-group One Dimensional Transport Theory (Reactor) Neutron and Photon Analysis." Heat transfer calculational techniques that were developed are now being employed in the *Pluto* nuclear ramjet project.

SYNTHETIC OILS—Considerable successful work was performed on the development of oils that could withstand the environment of a nuclear-powered aircraft for 1000 hours. Normal oils would congeal.

ELECTRONICS—Much data was collected on the effects of radiation on electronic components, and work was advanced on the development of components that can withstand the radiation environment. A wide application of this work to spacecraft is expected.

SAFETY—A number of significant fission-product dispersal experiments were conducted to determine the effects of the release of fission products from metallic fuel elements both in the air and on the ground. The results showed the margin of safety to be far greater than originally anticipated.

U.S. Studies Ways To Gain in Race to Moon

No immediate 'crash program' appears likely for several weeks; Congressmen seek budget boosts for NASA and AEC; moon landing seen possible by '67 if nation really wishes

KENNEDY ADMINISTRATION officials are now conducting new inquiries into whether the United States can catch Russia in the race to the moon.

But, in the backwash of the Soviet manned orbital flight, one fact stood out clearly last week:

The United States still did not have a well-defined—and funded—program for manned space exploration keyed to, or presently capable of overtaking the Russians.

Moreover, there was no immediate evidence that President Kennedy would order a "crash" military or civilian effort within the next few weeks. The choices before Kennedy were multiple, but none appeared to offer hope for a "quick fix" to the problem—simply because there were no programs which would lend themselves to a speed-up.

On the other hand there was general agreement that a space station in orbit and a manned landing on the moon were the next major milestones in the race. The question before Kennedy was, who could achieve these objectives faster? NASA or the Air Force?

• **Money call**—In reaction to Russia's latest space feat, House Space Committee Chairman Overton Brooks renewed his call for a NASA FY '62 budget of $1.5 billion, compared to $1.417 sought by NASA—and the $1.25 billion actually allowed by Kennedy.

Other Congressional voices urged increases in Atomic Energy Commission activity on the Project *Rover* nuclear rocket, which is required to parallel the NASA work.

Rep. James G. Fulton (R-Pa.) predicted that the Space Committee will vote to authorize at least the NASA request of $1.417 billion, as well as additions beyond the request of $5 million extra for solid propellants and possibly additions beyond the request of $47.6 million additional for the *Apollo* three-man spacecraft.

Fulton conceded that the Appropriations Committee may not go along with every penny added by the Space Committee. But the GOP member maintained that Appropriations will probably point to the open authority in the authorization bill and tell NASA to come back next winter if it feels it needs more money.

• **1967—If we care enough**—The question of a crash program was first raised at the Space Committee hearings. Dr. Robert C. Seamans, associate NASA administrator who attended Harvard with President Kennedy, said he feels a lunar landing by 1967 is possible if the nation really wants it.

Seamans reported the Kennedy Administration already has cut a year from the lunar landing timetable and now has set the period 1969-70 as the target date.

Rep. David S. King (D-Utah) noted that Russia is reported to have set her sights on 1967, the 50th anniversary of the Communist Revolution. He asked whether America could do as well. Seamans replied:

"This is obviously a very major undertaking. To compress the program by three years obviously means greatly increased funding would be required. . . .

"I certainly don't feel this is an impossible objective. If as a matter of national policy this is felt to be a requirement, I would be the first to review it wholeheartedly and see what it would take to do the job. My estimate at this moment is that the goal may very well be achievable."

Pressed for an estimate of the cost, Seamans recalled that NASA Administrator James E. Webb had put an overall pricetag of $20 to $40 billion on a manned lunar landing—depending on how fast a program is scheduled. "If you go all out on an absolutely crash basis, the cost will go up," Seamans commented.

"We are talking about a program that will cost $4 billion to $5 billion a year," he added.

Meanwhile, the House passed and the Senate Space Committee approved a bill designed to make possible a Kennedy Administration review of the space program under the leadership of Vice President Johnson. The bill makes the Vice President chairman of the National Aeronautics and Space Council and restricts the members to five, the other four being heads of government agencies. Statutory members would be the secretary of state, the secretary of defense, the NASA administrator and the chairman of the Atomic Energy Commission.

• **No Ceiling Set**—Dr. Edward C. Welsh, executive secretary of the Space Council, said in an interview that Kennedy has set no ceiling on the nation's space program and has not by any means ruled out a maximum effort to reach the moon.

Welsh said that when Kennedy allowed only $126.67 million additional he was not ruling out further additions later. The Space Council official said it was simply a question of immediacy. Everyone agreed, Welsh said, that it was necessary to get going right away on the speed-up of the booster program because it was the longest lead-time segment of the program. Now, Welsh continued, the administration is considering segments with the next longest lead time.

• **Cuts pinpointed**—The House Space Committee last week made a detailed inquiry into the NASA program to establish details of the requests made to the Budget Bureau under the Kennedy revisions.

Seamans told the committee under

(Continued on page 44)

NASA New Obligational Authority

	1961	1962		
	(including supplemental)	Eisenhower budget	Kennedy budget	NASA request
	(in millions of dollars)			
Salaries & Expenses	$170.76	$ 189.986	$ 196.686	$ 209.510
Research & Development	666.915	819.819	919.539	1056.309
Construction of Facilities	126.325	99.825	119.075	152.002
Total	964.000	1109.630	1235.300	1417.821

by Explorer X . . .

Solar Wind Existence Is Proven

NASA, MIT experts agree that satellite's measurements show force hurling from sun; new science of meteorology predicted

by Jay Holmes

THE SOLAR WIND theory of the interplanetary magnetic field seems to have been confirmed by the findings from *Explorer X*, the rubidium vapor magnetometer satellite.

Scientists of the National Aeronautics and Space Administration and Massachusetts Institute of Technology reported last week that the solar wind in quiet periods seems to be about 10 particles per cu. cm., traveling at a speed of 30 km/sec.

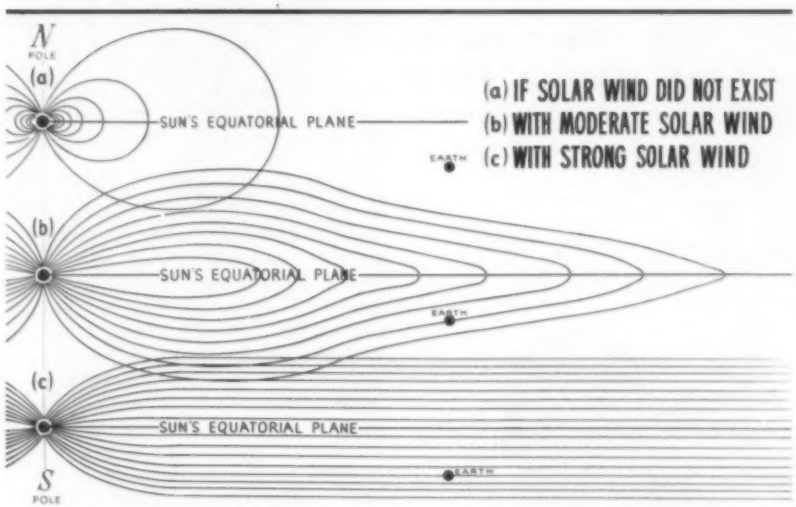
The satellite measured magnetic fields down to a minimum of 5 gammas in the region from 14½ earth radii out to its apogee at 36½ earth radii (145,000 stat. mi.). Such a measurement confirms that there must have been a solar wind flowing at the time of the flight—from the morning of March 25 until the evening of March 27, when the satellite's batteries burned out.

Dr. James P. Heppner of NASA's Goddard Space Flight Center, *Explorer X* project officer and director of the magnetometer experiment, said there is still a possibility that the solar wind occurs in gusts. But he declared there is no longer any doubt about the existence of such a wind.

The satellite also detected a period of violent disturbances in interplanetary magnetic fields beginning five hours before the appearance of a Class 3 solar flare. Heppner said the field jumped between 5 and 40 gammas during the disturbed period and on some occasions changed by 20 gammas within a few seconds.

About six minutes after the flare was sighted, the interplanetary field reverted from a disturbed condition to steady. Twenty-eight hours later, a sudden commencement (magnetic field disturbance) was recorded all over the earth. Two minutes after that, the sudden commencement was recorded by *Explorer X*, then more than 100,000 miles farther from the sun than was the earth.

The NASA and MIT scientists agreed that the sequence of events proved the sudden commencement was caused by something speeding out from the sun at about 3.26 million miles per hour.



SOLAR MAGNETIC FIELD is drastically affected by flow of wind.

Dr. Stanley Olbert of MIT reported that the *Explorer X* results seemed to indicate that the earth's magnetic field stretches out much farther than would be indicated by a simple dipole. One possible explanation, he said, is that the ring current from 6½ to 10 earth radii stretches out the field.

Dr. Herbert Bridge of MIT said the solar flare may have been a mixed blessing because it created more difficulty in the way of establishing what the interplanetary field is like during periods of solar quiet.

• **Transition data awaited**—Last week's report was based on analysis of about 10% of the tapes recorded by stations around the world while the satellite was operating. Data was reduced for the region between 3.8 and 6.5 earth radii and segments a half-hour to an hour long were reduced for several areas beyond 17 earth radii.

Data in the near region completely confirmed measurements previously made by *Vanguard III*, Heppner said. As a matter of fact, he suggested that in future flights a magnetometer might be converted to use as an altimeter in the near-earth region.

The earth's magnetic field is completely predominant in the near area, while in the more distant regions, the interplanetary field is predominant. No data has yet been reduced and translated for the transition region, believed to be from 15 to 20 earth radii. Olbert said that region will be the most interesting to scientists.

Heppner said the *Explorer X* data was not inconsistent with measurements of the interplanetary field made a year ago by *Pioneer V*. However, *Pioneer V* measured only the north-south component of the field and thus recorded only 2.7 gammas at a distance of about 24 earth radii.

Dr. Charles Sonett, assistant director of the Goddard Center, predicted that a new science of interplanetary meteorology will be developed from findings about the fields and noted the obvious implications for predicting the hazards of manned flight.

All the scientists emphasized that more measurements at different times and on flights in different directions will be necessary to make firm statements about the nature of interplanetary space. The next such measurements will be made by *Ranger I* and *Ranger II*, to be launched later this year. ⌗

AF Orders 'Quick Change' Space Suit

Latex design, representing six years' work, is highly flexible and can be donned single-handed in minutes

by Heather M. David

LATEX SUIT is modeled by T/Sgt. Gene Fritz at Air Force's Wright Air Development Division altitude chamber.

A SPACE SUIT which offers almost complete mobility even under full pressure has been designed by the International Latex Corp. for the Air Force.

So flexible a man could make delicate repairs to his spaceship while wearing it, the suit could be used for any space voyage planned for the next decade. It is adaptable to prolonged usage outside the space vehicle, on the moon or for interplanetary travel, according to its designers.

The biggest breakthrough offered by the suit is the mobility afforded the wearer in every joint. The intricately convoluted design of the joints of the inner layer is the result of some six years of work. The joints contain no heavy metal gimbals or cumbersome reinforcing straps and the total weight of the suit, boots and helmet is only 21 lbs.

Another advantage is that the suit can be donned quickly with no help. This makes it adaptable to the "shirt-sleeve" concept of space travel—in which the suit would be put on for hazardous periods or for work outside the vehicle. Project engineer George Durney said the donning time of several minutes would be fast enough to meet 90% of all foreseeable emergencies.

Oxygen supply can be obtained by hooking up the suit by umbilical to a vehicle supply, or attaching a separate backpan designed by the Garrett Corp. This backpan supply can be designed for almost any duration, but probably would average four to six hours.

The suit can be pressurized with pure oxygen to 5 psi. This compares to about 3.5 psi for the *X-15* suit and about 4.5 psi in the *Mercury* suit. Even under full pressure the wearer has tactile sense and mobility in his fingertips, but he must wear a protective glove when handling extremely hot articles.

The suit cooling system is continuous even when not under pressure and can be regulated to any degree by the wearer. Latex said it had been tested up to 35 minutes at 260°F without an appreciable rise in the subject's body temperature.

Material used in the suit is classified but basically contains layers of aluminized fabric, nylon and neoprene welded at the joints. Like existing suits, the outer layer is thermal radiation-reflective, but the manufacturers say it also protects against particle radiation. This protection is adequate to allow the crewman to emerge from his vehicle except during passage through the Van Allen belt and during a heavy solar flare.

International Latex has been working on the project under three Air Force Wright Air Development Division contracts totaling $250,000 for the past six years. ■

Canada and NASA

Satellite with 75-ft. Antennas to Ride Javelin

by Bernard Poirier

CANADA IS now designing a satellite with 75-ft antennas to probe the upper ionosphere in its first joint space experiment with NASA next year.

The *Longlegs* payload, part of the international *Top-Side Sounder* program, will record galactic emissions and other information valuable to improving long-range communications.

First details of *Longlegs* made available to MISSILES AND ROCKETS show the Canadians will employ a coiled carpenter's rule technique to extend the antennas in orbit. The technique will be tested in the nose cone of a *Javelin* rocket being launched from Wallops Island, Va., in June.

The girdled and flattened satellite, constructed principally of aluminum, is scheduled to be launched into a nearly polar orbit by a NASA rocket fired from Vandenberg AFB, Calif., in the first quarter of next year. Inclination will be 80° at an altitude of 625 miles and the orbital period about 105 min.

Built by the Electronics Laboratory of Canada's Defense Research Telecommunications Establishment (DRTE), *Longlegs* will have two sets of antennae. The second will be 37 ft.

Longlegs' sounder uses miniaturized radar transmitting sounding pulses and measuring the echo's return time. This data will be relayed by four 20-in. telemetry antennas to ground stations at Resolute Bay, Prince Albert, Ottawa, St. Johns, Alaska, Florida, Chile, Ecuador, England and Malaya.

The special antennas are made of thin heat-treated steel, coiled on drums for automatic extension. Uncoiling after separation, they will then form themselves into rigid tubes extending through specifically-designed guides, say the Canadian scientists.

• **Beacon fixed**—*Longlegs* will resemble a flattened sphere and will be girdled by banks of solar cells. The diameter of the girdle will be about 42 ins. and overall weight will approximate 270 lbs.

Objectives of *Top-Side Sounder* are to (1) examine and record fundamental scientific information about the structure of upper levels of the ionosphere by radio sounding techniques and (2) provide information about galactic noise or radio signals that emanate from outer space.

In addition, payload space has been allotted for instrumentation developed

(Continued on page 44)

NASA Gives Go-Ahead to Segmented UTC Motor

A CONICAL, flight-weight segmented solid motor of 250,000 lbs. thrust will be test-fired by United Technology Corp. late next summer.

UTC, a subsidiary of United Aircraft Corp., will build the motor under a development contract from the National Aeronautics and Space Administration. The three-segment unit will weigh over 75,000 lbs. and operate for more than 60 seconds.

UTC spokesmen say it is the initial step in the development of a family of low-cost solid boosters. The largest of these motors could deliver more than 3 million lbs. thrust; clustering could up this to a booster stage with more than 15 million lbs. thrust.

The segments in the first test motor are coupled through a circumferential clevis joint. The rim of one case-segment fits into a notch in the next section. The notch also holds a simple "O" ring and the joint is made fast by inserting shear pins in previously drilled holes. A pin retention strap completes the assembly.

UTC recently completed a feasibility program (M/R, June 13, 1960, p. 35) which involved the design, fabrication and test-firing of three flight-weight, conical, segmented motors of 15,000 lbs. thrust.

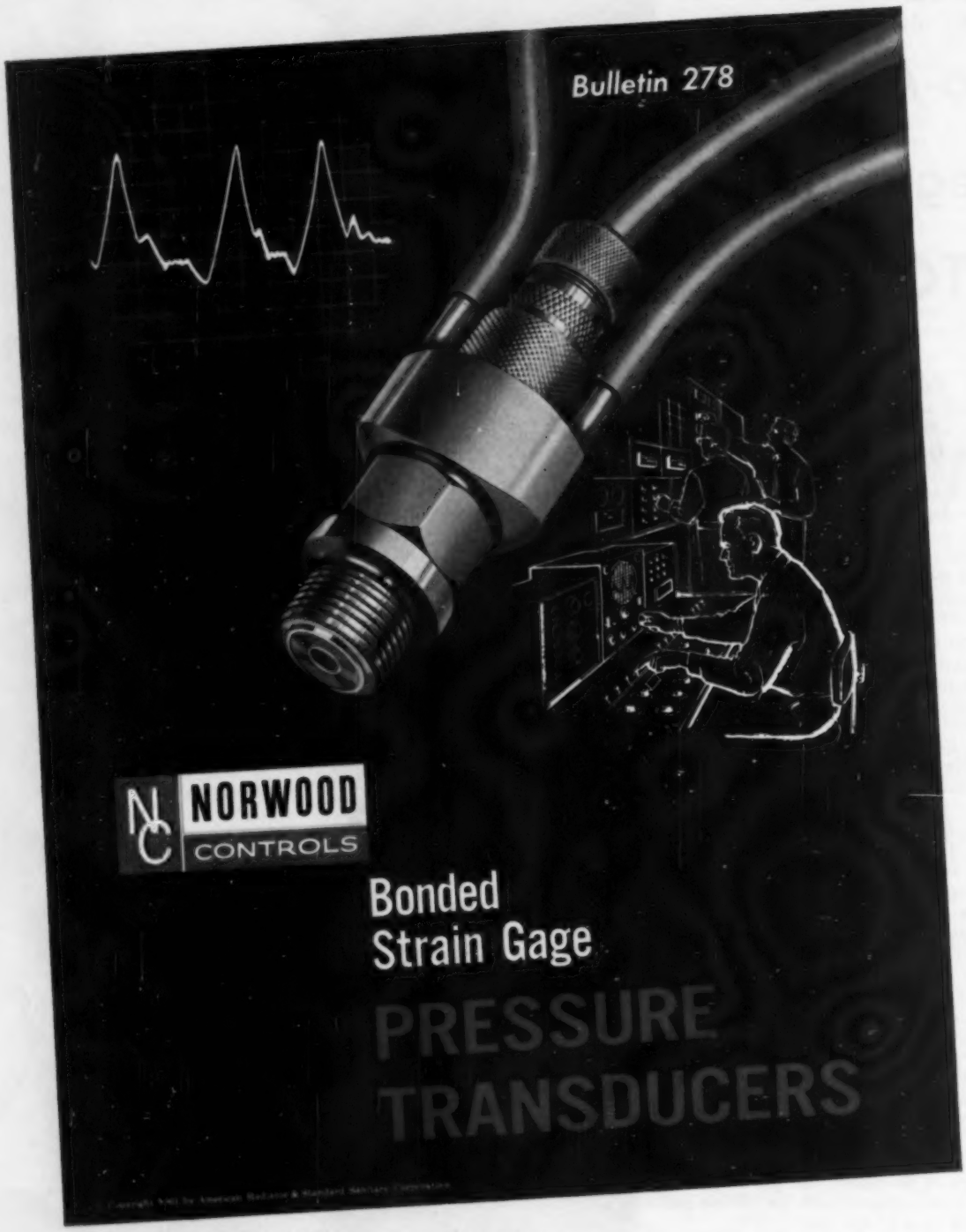
Each of the three motors had three segments and all were successful.

The conical shape eliminates erosive burning in long solid grains. The propellant thickness is the same for the length of the motor. The gas flow channel is cone-shaped, with the narrow end at the head of the unit.

The program is expected to provide additional information in many areas including propellants, segmentation joints, large uncooled nozzles and ignition methods. Work will be carried out at the firm's new research and development facilities on the San Francisco peninsula. ⠿

FULL-SCALE MOCK-UP of three-segment, conical solid motor shows characteristic tapered UTC configuration. Single motors could develop 3 million lbs. thrust.

HOT OFF THE PRESS



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Technical Countdown

SUPPORT EQUIPMENT

BMEWS Radar To Track Satellites

The prototype BMEWS tracking radar built by RCA at Moorestown, N.J., will be used to detect and track satellites for the Air Force. Initially, a three-month study program will determine the capability of the huge radar as a space surveillance aid. The facility has already tracked the moon, earth satellites, and missile and rocket launchings from Canaveral and Wallops Island during its prototype test phase.

Titan II Has Own Weatherman

Martin-Denver has installed a compiete weather observation and forecasting station for the *Titan II* test program. A four-man meterological team will predict weather for scheduling static firing tests and observe conditions during tests as an aid in analysis.

Flat-Screen TV Display Developed

A new approach to flat-screen optical displays, using molecular electronics, has been developed by Electro-Tec Corp. Details have not been revealed, but the development is reportedly so basic that it could have a significant effect on a wide variety of materials and instrumentation—including the obvious TV screen hanging on the wall.

AF Simulator Combines Missile Torture Tests

A new simulator developed for realistic testing of ballistic missile components can simultaneously provide steady acceleration, vibratory acceleration, and extreme temperatures. The unit consists of a 450-lb. force electrodynamic vibrator and high-temperature oven mounted on a large-mass centrifuge.

Missile Checkout Methods Applied to Aircraft

The Army is studying the use of electronic checkout techniques developed for missiles to preflight-test aircraft. Bendix is researching the ALARM concept, which will automatically check flight readiness of critical mechanical and structural components.

Transit Equipment for Polaris Subs

Million-dollar test instrumentation equipment for the new 616 class of *Polaris* nuclear submarines will include receivers for *Transit* satellite navigational data. Sophisticated second-generation instrumentation leans heavily toward digital equipment for recording and data reduction. Nine systems will be built by Interstate Electronics Corp. under a $9.5-million contract.

Telemetered Data Relayed Cross-Country

Telemetered test data received from *Hound Dog* missile flights at Cape Canaveral is relayed instantaneously to North America's headquarters at Downey, Calif. The new system allows NAA engineers to monitor the missile's flight while it is in progress and analyze critical data within five minutes.

ELECTRONICS

Accurate RMS Measurements

Newest development out of the National Bureau of Standards is r-f thermal voltage converters for accurately measuring rms voltages. The converter—a resistor in series with a thermoelement in a coaxial line—can measure rms voltages of 1-200 volts at frequencies up to 30 mc. Accuracies are 0.1% at the low end and 0.2% at the high.

Circuit-Board Production Speeded

Production of printed-wiring boards has been more than tripled at Lockheed by improvements in manufacturing techniques. New methods include multiple hole-drilling, automatic soldering and cleaning, and single-operation tabbing of inserted wires.

Seawater-Bacteria Battery

There are unconfirmed reports that a method has been found to extract energy from the ocean by use of an "oceanic battery" composed of iron cathode coated with bacteria and magnesium anode. The battery gets energy from naturally occurring ions in some ocean solids—nitrates, carbohydrates, sulphates, and others. Power output is said to be five times that of ordinary magnesium types.

ADVANCED MATERIALS

Russians Using Glass Fibers in Nuclear Fuel

Nuclear fuel elements made of glass fibers containing oxides of uranium 235 have been tested in Soviet nuclear reactors. The approach makes it possible to operate the reactors at temperatures up to 1000°C. The Russians are also looking into incorporating the oxides of thorium and plutonium with the glass fibers.

Sulfur Belt in Stratosphere

The Air Force has discovered a world-wide aerosol layer consisting mainly of sulfur particles. The 3-mile-thick shell completely surrounds the earth at an altitude of about 11 miles. The layer, which also contains silicon, iron and aluminum, may explain certain twilight effects such as the red disk frequently seen above the point of sunrise or sunset.

Magnesium-Lithium Alloys for Space

Battelle Memorial Institute metallurgists suggest that Mg-Li alloys would be valuable for lightweight, light-load carrying space structures. The alloys resist spalling and penetration by high-velocity fragments. This could be useful in micrometeoroid shielding.

PROPULSION

Saturn Upper Stage Model Cluster Fired

Simultaneous ignition of a four-engine, hydrogen-oxygen, scale-model cluster has been achieved by Marquardt Corp. The model was built for Douglas to determine the effects of the intense heat of the S-IV engines on the structure and systems in the vehicle's base at altitude.

AIRESEARCH designs, develops, manufactures and tests a *complete* line of cryogenic valves and controls in individual packages or complete systems for missiles, space vehicles and related ground support equipment.

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4. *Airborne pressure relief regulator and vent valves for propellant tank.*
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6. *Airborne liquid propellant shutoff valves.*
7. *Ground support pressure regulator and shutoff valves.*

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NBS Plans Basic Propagation Studies

Bulk of Kennedy-proposed budget addition would go to Boulder Lab for program of fundamental research

by Hal Gettings

A PROPOSED increase of $750,000 included in President Kennedy's revised Fiscal Year 1962 budget request would add considerably to the knowledge needed for practical satellite communications.

The National Bureau of Standards would use the money to find the answers to some basic problems in radio propagation in space.

NBS says this basic information is a prerequisite to intelligent frequency allocation and the development of optimum equipment and techniques for space telecommunications systems.

The funds are not yet in hand; budget hearings to be held soon will decide the fate of the program.

NBS contends that current needs in this fast-developing area indicate that the effort must be expanded by $4-6 million, but that such an acceleration would be impossible within a single fiscal year.

The bulk of the additional money—$650,000—would be used for operating costs. Only $100 million would go for new equipment.

The proposed Bureau program does not include the launching of any satellites purely for propagation experiments during the first year. Possibly, however, specific experiments might ride on satellites launched for other projects.

The program would be conducted by the Bureau's Central Radio Propagation Laboratory, Boulder, Colo. Proposed investigations would center around several important facets of the problem:

—Research in atmospheric absorption. Influence of the atmosphere on radio propagation at frequencies above 10 gc (kmc) becomes increasingly important as the potential use of these frequencies for space communications grows. At frequencies above 1 gc, present rates of atmospheric absorption and sky temperatures are based on limited models of the earth's atmosphere. NBS says it is necessary to expand these data as a function of time and climatic conditions and to correlate the radio and meteorological measurements. These measurements should be designed to develop methods, based on simple meteorological measurements, to predict performance of a space communication system with terminals located anywhere on the earth's surface.

—Extension of tropospheric propagation theory to space communication systems. Present tropospheric propagation theory is the result of extensive theoretical analysis of data on the dependence of system performance on many variables such as frequency, distance, antenna heights, topography, and meteorological conditions. This work, extended to space telecommunications problems, would take into account satellite heights, atmospheric disturbances, changes in refractive index, and turbulence.

—Mutual interference between surface and space communication systems. The possibility of interference between surface and satellite systems operating on the same frequencies requires the prediction of interfering fields. Limits of interference must be known in order to assure adequate safeguards for the systems involved and, at the same time, make efficient use of the frequency spectrum. The widely divergent results predicted by currently available theories can be resolved only by actual measurement of results. In particular, it is important to determine the extent of low-transmission losses which may occur when the very narrow beams of large antennas are directed well above the horizon.

• Application of modulation studies to tropospheric terminal equipment. Owing to a large radio wave transmission loss and the fading characteristics of the received radio signal, present-day multichannel tropospheric radio communication systems require comparatively high transmitted radio-frequency power for effective operation. High-gain antennas and various diversity schemes have partially overcome these difficulties, but they add substantially to the cost and complexity of the systems. A very promising area for improvement, however, is believed to be in the radio receiver. The proposed project would include standard comparison tests on wideband radio receivers to determine which type gives the best performance. Various types of improved demodulation methods also will be considered.

• Radio meteorology. Although only indirectly related, fundamental knowledge of tropospheric propagation is important in connection with problems of tracking and communication with satellites and missiles. The increased program would permit more adequate investigation of the combined effects of temperature, wind, atmospheric pressure and refractivity on radio propagation.

• Radio noise. Increased attention would be given to the measurement of external radio noise and its effect in limiting the usefulness of various types of communication systems. Study would include the three principal types of radio noise: man-made, atmospheric, and galactic. Increased effort on noise measurement techniques and analysis of data is also planned.

• Modulation research for satellite communications. The problems to be encountered in this area arise from the fact that effective world-wide communications through the use of satellites require that wideband systems capable of handling large quantities of information be developed. Methods of encoding the information and modulating the r-f carriers must be designed with due consideration for the perturbations imposed on electromagnetic waves propagated through space.

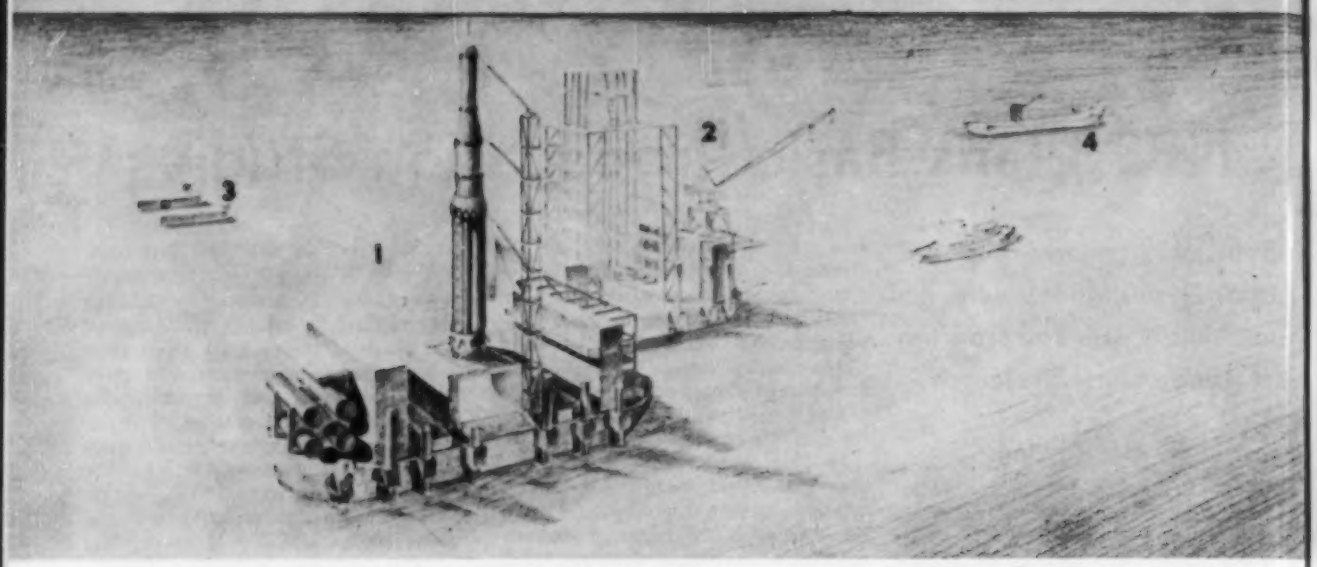
• Antenna research. The weightless, frictionless environment of satellites makes possible unique antenna designs. These are important factors in improvement of communication systems design because of their significant role in determining power requirements and interference effects.

NBS has some weighty arguments on the side of an increased effort in space communications research.

President Kennedy, in his State of the Union message, invited all nations to "join with us in developing . . . a new communications satellite program and in preparation for probing the distant planets. . . ."

James M. Landis, in his report on the regulatory agencies, called for improved coordination and development of communication policy and better control and allocation of the radio-frequency problem.

(Continued on page 48)



FLOATING DRYDOCKS for launching Saturn-class vehicles includes AFDB's for (1) launch platform, (2) service platform, (3) blockhouse. An ARD drydock (4) is used for vehicle transport and assembly.

sea launching

Flexibility Behind Idea For Drydock Platforms

by William Beller

THE IDEA of launching large space vehicles from water-borne mobile platforms is still being considered seriously by the Defense Department and the civilian space agency—even though there is no money for the project.

Such platforms continue to offer the beguiling advantages of flexibility in chosing a launch site and minimum hazard in the event a large rocket explodes or a prospective nuclear rocket aborts.

Any agency is keenly appreciative of these advantages when it is charged with attaining specific orbits for its satellites and also with continuously protecting its launch crews and the native population.

Meanwhile, the Navy's Bureau of Yards and Docks and also the Pacific Missile Range have been proposing ways to use some of the mothballed floating drydocks as economical mobile launching sites. Much merit is seen in their proposals, especially because these docks are equipped with many of the shops and facilities needed for ground support equipment.

Commercial organizations have also seen the possibility of using Navy vessels as launching sites. Among these are Boeing, Douglas, Hayes Aircraft, and the company of Daniel Mann, Johnson and Mendenhall.

The towable docks the Navy uses to drydock its ships, chiefly at remote locations, can be stabilized in shallow water by DeLong-type spuds which would jack the docks partly out of the water.

• **Water versus land**—Here are some of the ways in which the mobile launch may have the advantage over the land-based launch of a space vehicle:

—When a specific orbit, such as equatorial, is wanted, the launch point can be appropriately chosen. There is no need to dogleg the satellite from an inclined orbit, and therefore no weight or reliability penalty.

—Hazards can be reduced—particularly those that endanger populated areas by explosions, spread of propellant combustion products, exhausts from possible nuclear jets, and hardware fallout from an aborted flight.

—With the cost of real estate continuing to rise in populated areas, the price of enlarging the launching bases and buying buffer areas as a shield against hazard and noise is already prohibitive; a water-borne launch, particularly at a remote location, will be relatively economical.

—Covert tests can be made with maximum security.

Other advantages stem from the fact that building fixed overseas bases—which might be necessary to accomplish launch objectives—brings in political as well as cost problems. Base rights have to be negotiated for; facilities once built have only small salvage value to the United States.

On the other hand, stationing the mobile base in international waters would not only lessen political problems but also the facility would be 100% salvable.

Moreover, the complete facility can be checked out stateside, close to equipment manufacturers and management headquarters. Also, by building the facilities in stateside shipyards and thereby eliminating foreign construction work—work whose cost is said to range from 2.5 to 3 times stateside cost—there are

savings in money as well as time.

• **Drydocks get the nod**—BuDocks has studied two types of launchings, those in the *Centaur* class and the *Saturn* class.

For the *Centaur*-class vehicles and those up to 1.5 million-lb thrust, the BuDocks' concept calls for using an ARD floating drydock. These ARD's have been drydocking destroyers since the beginning of World War II and have tens of thousands of operational hours to their credit. They are nearly 485 feet long and can take on a load of 3500 tons.

When drydocking a destroyer, the ARD—which is simply a hollowed-out hull with its aft end a watertight door—takes on water until its deck sinks and the destroyer is floated aboard. Then the hinged door is closed, water pumped out of the ARD, and the destroyer is raised clear of the sea.

BuDocks says that an ARD, which can be towed up to 11 knots, can carry two or three *Centaur* types to a launch site. All facilities on board will have been assembled and checked out stateside.

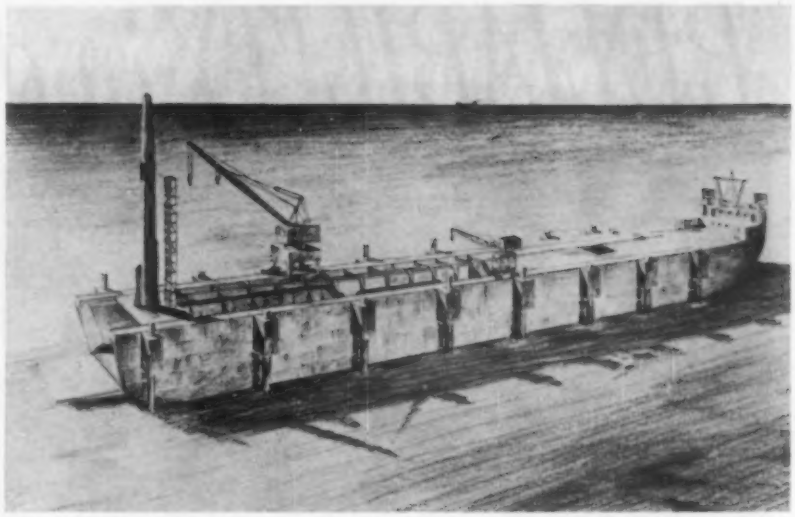
On site, the drydock will be stabilized by DeLong-type jacks and caissons, which will be hydraulically controlled. In effect, this system of spuds takes on a small part of the buoyant load and lifts the drydock a foot or so higher in the water. These spuds can be used in water up to 200 feet deep.

Captain Harry Stevens, Jr., director of BuDocks' engineering division, and John Filipowski, BuDocks architect, emphasize that the launch pad on the ARD will be useful for larger vehicles as well as for *Centaur* types. A water-cooled or dry deflector will pass the rocket's exhaust aft over the stern gate. The obvious approach of shooting the rocket exhaust directly into the sea is not used because of its scouring effect on the stabilizing caissons.

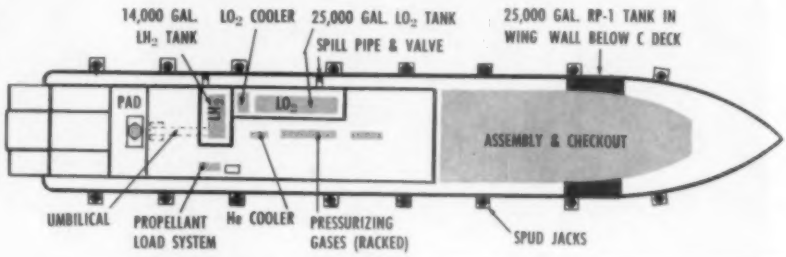
The "blockhouse" aboard the ARD, modified for overpressuse, can be located in the bow. Fuel tanks, cranes, and a retractable gantry can all be part of the facility.

Not a cubic foot will go to waste. Shop areas without a launching func-

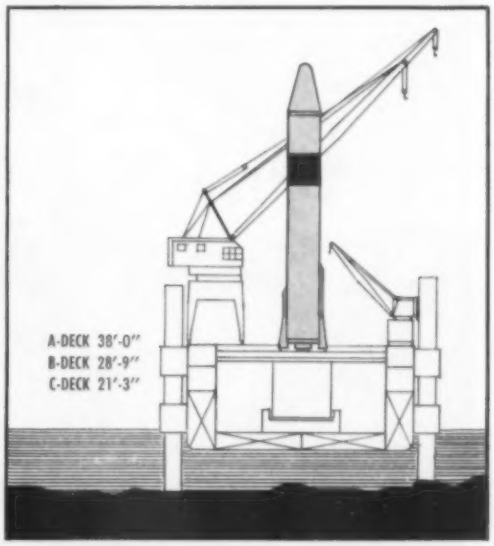
(Continued on page 48)



ARD DRYDOCK suitable for servicing and launching Centaur-class space vehicles is stabilized by a system of DeLong-type hydraulically controlled spuds.

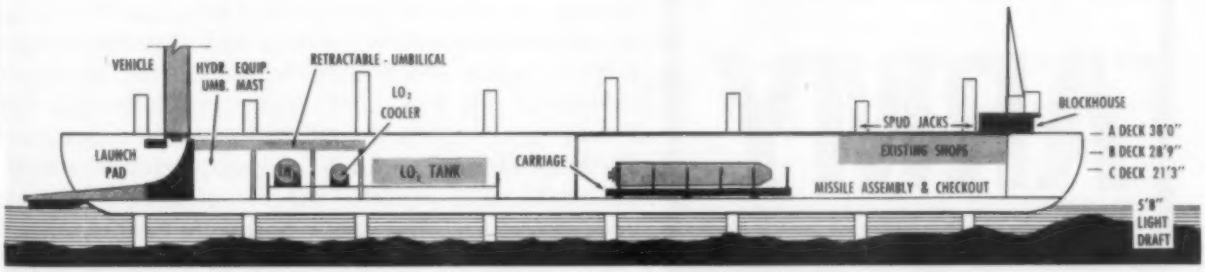


ABOVE: *ARD plan shows stowage for propellants and locations of spuds.*



RIGHT: *Existing cranes are adequate for handling Centaurs.*

BELOW: *Section view shows jet deflector which can be either water-cooled or dry.*



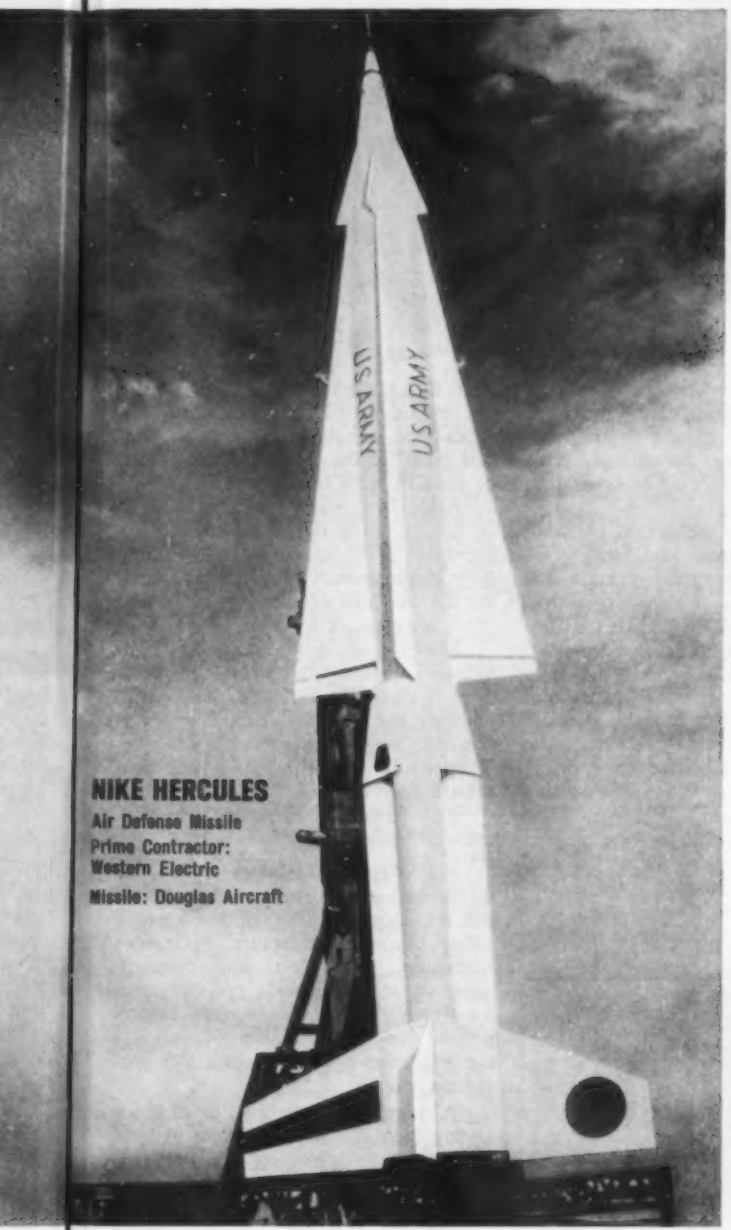
RELIABILITY in depth, from

NIKE ZEUS
Army's Anti-Missile Missile
Prime Contractor: Western Electric
Missile: Douglas Aircraft

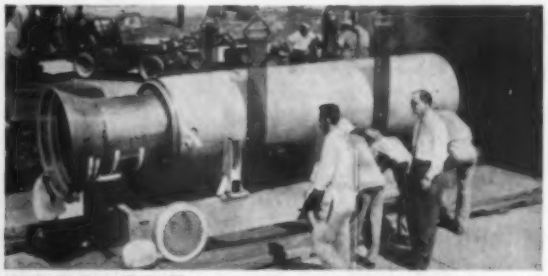
ARMY

Scientific and engineering groups at Thiokol, functioning as part of the Army Ordnance team, have developed propulsion systems of total reliability for a wide range of military requirements. Motors for Lacrosse, and for the developmental Sergeant and Pershing, the modern field artillery—powerplants for the Nike Hercules and Nike Zeus, defenders against air borne and ballistic missile attack . . . these are products of the joint Army-Thiokol effort. Additional capabilities for Army's advanced thinking are pro-

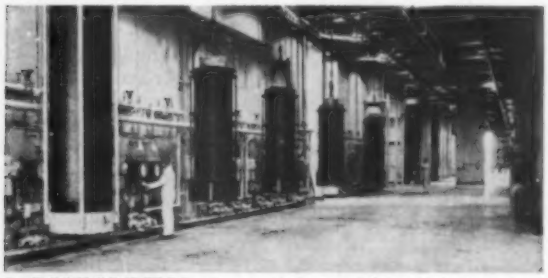
...research through production



NIKE HERCULES
Air Defense Missile
Prime Contractor:
Western Electric
Missile: Douglas Aircraft



REDSTONE *The most powerful single solid rocket booster ever fired in the free world—450,000 lbs. thrust—was developed for the Army's Nike Zeus program at Thiokol's Redstone Division. The motor is a product of research from propellant formation to scale-up and development of largest thrust rocket motor to-date.*



LONGHORN *Production techniques of the most advanced nature are featured at Longhorn, to assure the military a steady flow of rocket motors of unvarying dependability. Through combined divisional efforts, Thiokol is producing reliable powerplants for the key air defense and anti-missile missiles, the Army's Nikes . . . Hercules, now operational and guarding major population centers . . . developmental Zeus, whose repeatedly successful R&D launchings underscore Thiokol capability to design and deliver rocket motors to meet every tactical requirement.*

...vided by other Thiokol Divisions. Utah, for large engine production — RMD, for sophisticated ... liquid systems -- Elkton, for diversified special motors.

...Experiences gained through their development . . . basic laboratory research into high energy ...fuels and materials, new processing and evaluating ...methods, automatic production and quality control ...techniques, the most advanced and fluid research and ...manufacturing facilities... all have added immeasurably to the progress of Rocketry, U.S.A. All can be brought to bear in the most challenging future projects of the space age.

THIOKOL

THIOKOL CHEMICAL CORPORATION, Bristol, Pennsylvania
Rocket Operations Center: Ogden, Utah

Direct Winding May Cut Case Cost

Filament technique under development by Grand Central and Aerojet would obviate need for making propellants withstand broad temperature range

by Frank G. McGuire

LOS ANGELES—Cost of glass motor cases may be sharply reduced by filament winding directly onto a solid-propellant grain.

Grand Central Rocket Co. and Aerojet-General Corp. are developing the technique, aimed at eliminating stresses in the final product. They warn that several problems must still be solved before its full money-saving potential can be realized.

Charles E. Juran, of Grand Central, says the chief advantage of the method is that it sidesteps the need for making propellants capable of meeting broad temperature ranges.

Ralph J. Brown, Jr., head of preliminary design at Aerojet's Structural Materials Division, reports that good results were obtained in the firing of a small test motor last October; a 90,000 psi composite stress was withstood by the solid rocket during firing.

Crux of the problem is that differential thermal shrinkage between propellant and case during cool-down from curing introduces stresses in the propellant which are sometimes great enough to cause cracking or separation from the case wall.

In addition to the actual cracking or separation, Juran said, the stress levels can cause marginal grains which are sensitive to minor stress concentrations or operational loads. This is particularly noticeable in large motors.

Current practice is to use rubber liners, mechanical stress relief, pressure curing and other techniques to alleviate the stresses. In all these methods the shrinkage is permitted to take place; attempts are made to design cases around the problem.

In the technique under development at GCR, the case is filament-wound directly on the pre-cured grain at ambient temperatures, then stressed only to the extent that the motor deviates from that temperature.

Juran described the application as a logical one, merely substituting the precast grain for the mandrel which would be used to wind the case anyway.

Aside from the basic advantage to be gained, GCR is looking toward improvements in mass ratio, resulting from elimination of rubber liners, winding the case and nozzles integrally, and other weight-saving steps.

Modified grain design to take advantage of eliminated stress considerations is also to be expected, Juran says, pointing out that the grain designer is presently severely limited by stress restrictions in the geometry of the propellant core.

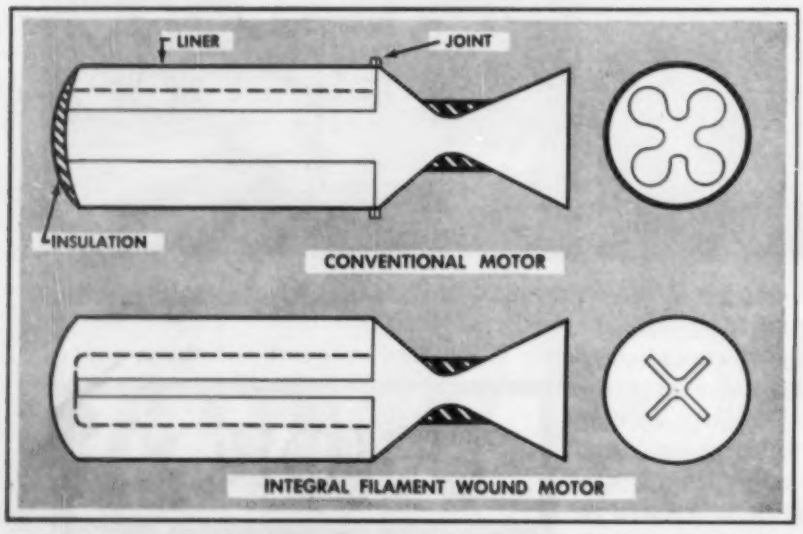
The technique is compatible with mass production.

• **Problems remaining**—Still to be solved before the application is finally put into common use are problems of safety during manufacture, resin cure techniques, inspection, and compatibility of materials with propellants.

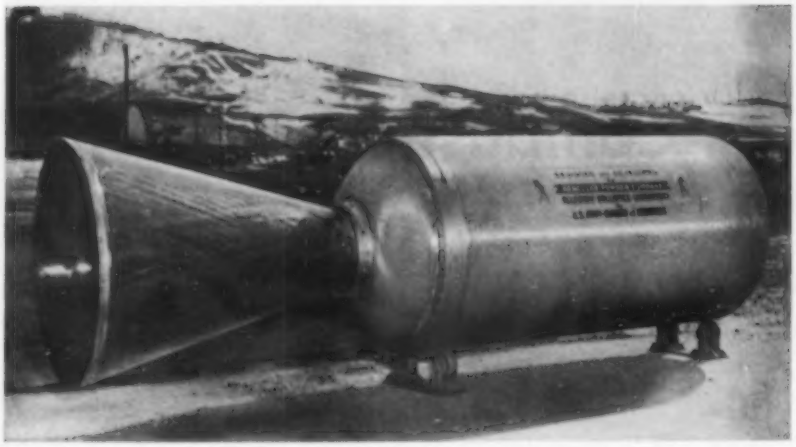
Fabrication safety obviously centers around the undesirability of carrying out extensive operations on a live propellant charge.

A production problem is that of curing the resin in the system without simultaneously elevating the temperature of the grain. The compatibility problem, in addition to chemical considerations, includes adequate bond strengths. No insurmountable obstacles are expected in this area because the multiple-use resins to be used in the filaments have previously been used directly on propellants for bonding and inhibiting.

Geometry of the winding pattern is expected to be quite similar to that which would be used if the grain were an inert mandrel. The principal concern is careful handling and physical support of the grain itself, particularly those very large grains where stress-



CUTAWAY DRAWINGS of conventional and integral filament-wound motors, with cross-sections of grain at right. New method is expected to improve mass ratio.



REINFORCED PLASTIC nozzle liner produced by Tapco Group has been worked into Antares third-stage Scout 29.5-in.-diameter exit cone by Allegany Ballistic Lab.

free features are most desirable.

Where the grain cavity diameter is not greater than the diameter of the throat nozzle, a modified mandrel with end support pins can be used. In cases where this cannot be done, a segmented mandrel is feasible, being removed after winding is complete. Even a soluble or fusible type of mandrel could enter the picture.

If insulation should be desirable in the finished motor, such materials can be applied directly to the grain before winding. This is easier than trying to lay up insulation inside a chamber, where access and inspection are difficult.

• **Curing the case**—Most critical phase of the operation will be the winding cure, which must be adequate to utilize as much strength of the resin as possible, while maintaining enough of a safety margin to prevent grain deterioration or even autoignition.

The process must also insure that return to ambient conditions does not introduce the very shrinkage problems which the technique is designed to avoid.

Juran points out that variations in resin curing techniques may have to be found, including possibilities of using ultraviolet or infrared radiations. Effects of these on propellant must first be ascertained, he said.

Combining high strength with reasonably low curing temperatures has been the prime influence in past selections of resin systems. However, even though epoxy cure temperatures are in the range of 180 to 370°F, which is well below autoignition points of propellants to be used, there is still a problem from accelerated aging or cure shrinkage in the propellant.

Juran proposes radiant heat lamps for surface curing of the case, rather than in an elevated temperature atmosphere, due to the necessity for curing the wound surface of the grain but not the surface of the core itself.

Pigments in the resin are suggested as a method of preventing excess heat transfer from the filament to the grain, but pigments would also retard inspection.

Reduction of the thermal range requirement to 55% of the former value is another advantage to be expected from the ambient-temperature winding technique.

As an example, Juran cites a conventional cast-in-case propellant poured at 180°F, which military requirements say must withstand temperatures to as low as −65°F. The charge drops 110°F during curing, then is expected to be fully usable to −65°F, amounting to a temperature range of 245°F.

If the same charge were filament-wound in a stress-free condition at +70°F, still with the operational requirement of −65°F, the range would be greatly reduced.

• **Mass ratio improvements**—An improvement in inert weight factors would result from elimination of the insulation, lining and various bits and pieces of hardware used during manufacturing operations. Steps in fabrication are also cut out in the process.

Improved volumetric loading of grains would be another gain from introduction of the technique, which presents ways of sidestepping the limitations placed on designs with a given chamber area.

Present grain configurations must maintain thin, flexible webs, resulting in low volumetric loading, and large radii of curvature, causing large sliver losses.

Design considerations are currently more restricted by thermal cycling problems than by ballistic requirements.

Grand Central's development was described by Juran at a symposium of the Society of Aerospace Material and Process Engineers. ⌗

Record Saturn II Contract Award Expected in Autumn

A CONTRACT for the largest rocket ever built by private industry—the 800,000-lb.-thrust *Saturn S-II* stage—is expected to be awarded in October or November.

The M/R estimate of total cost is $220 to $240 million.

Under a speedup ordered by President Kennedy, the National Aeronautics and Space Administration held a pre-proposal conference at Huntsville last week. Initial proposals are due at the Marshall Space Flight Center May 11.

From the early proposals, which will outline companies' capabilities and past experience, NASA will choose a smaller number of companies to submit detailed bids with cost information.

Specifications for the *S-II* stage are still being written. However, this much is known:

The rocket will be 74 ft. long and 21½ ft. in diameter. It will have the capacity to carry 350,000 lbs. of LOX and liquid hydrogen propellants to power the four Rocketdyne J-2 engines, which will have specific impulse slightly over 420 sec. Thus, the stage will have propellant capacity for about 180 sec. of operation.

The stage weight will be 30,000 to 45,000 lbs. unloaded.

First flight test of the *S-II* stage—with live *S-I* and *S-II* and dummy *S-IV* and *S-V*—is scheduled for 1964. A seven-flight program has been laid out with the idea of making the *Saturn C-2* vehicle operational in 1966.

Saturn C-2 is to have a boost capacity of 45,000 lbs. in orbit, 15,000 lbs. to escape velocity and 10,000 lbs. on a probe to Mars or Venus. However, the vehicle is to be especially designed for its escape capacity, since its most important mission is to boost the 15,000-lb. second-phase *Apollo* manned spacecraft on a mission around the moon. It also will have the job of boosting the *Prospector* mobile remote-controlled lunar landing craft for unmanned exploration of the moon.

To date, there have been full 200,000-lb.-thrust firings of J-2 thrust chamber, full-scale fuel pump tests and model tests of other components. NASA propulsion specialists report the work is right on schedule.

NASA invited 20 companies to the pre-proposal briefing:

Avco, Bell Aircraft, Bendix, Boeing Airplane, Chance Vought, Chrysler, Convair, Douglas Aircraft, Firestone, General Electric, Hughes Aircraft, Lockheed Aircraft, Martin, McDonnell Aircraft, North American Aviation, Northrop, Raytheon, Sperry Rand, United Aircraft and Western Electric.

Data Lacking on Combustion Problems

NEWPORT BEACH, CALIF.—Possible effects of erosive burning in solid rockets and ignition in confined pores within propellants is causing some concern to designers of future large boosters and motors having ultrahigh-burning-rate propellants.

Papers presented at the spring meeting of the Combustion Institute's Western States Section, held at the Aeronutronic facility here, showed a lack of complete technical data on both problems.

Limited to 12 formal papers and a number of short presentations on recent work, the meeting drew over 120 participants from industry and other research groups.

Significance of erosive burning in the accurate prediction of performance curves for solid-propellant boosters was described by Drs. E. J. Fenech and J. S. Billheimer of Aerojet-General Corp., who emphasized that much more data on actual firings is needed before the phenomenon is completely understood.

Dr. Fenech noted that the configuration of the flow cross section in the grain core greatly influences the magnitude of erosive burning, in addition to the classical effect of burning rate on the erosive constant.

A lively cross-fire discussion brought general agreement that there is some characteristic length which identifies erosion flow in each grain design, similar to the hydraulic radius concept of annular flow channels.

However, in rocket motors the relation of mass addition from a receding boundary surface overshadows the conventional Reynolds analogies, Billheimer stated.

C. A. Saderholm, of Thiokol's Redstone Division, also presented data on small-scale tests of propellant tablets for erosive burning characteristics.

Final consensus was that considerable work remains to be done in formulating a true boundary layer condition to obtain accurate erosive burning coefficients for use in designing motors of minimum overpressures for application in future high-thrust solid propellant boosters.

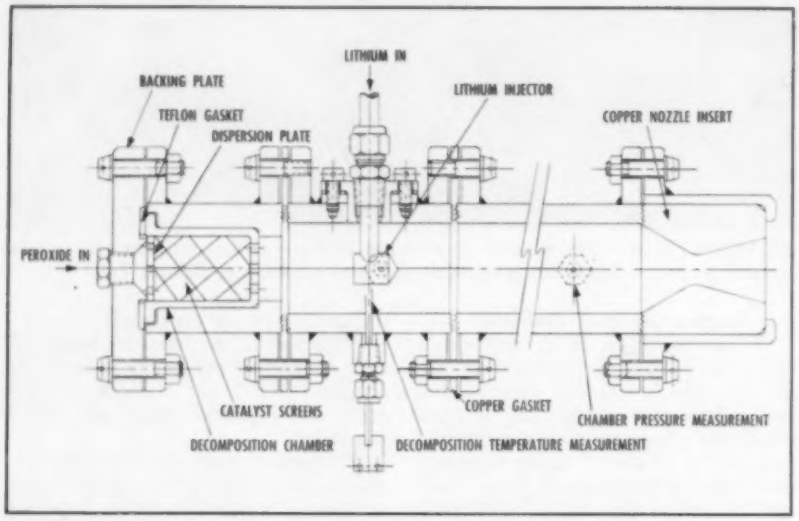
• **Runaway phenomena**—A complex situation of ignition and burning in confined pores of propellant was laid out by G. D. Artz and F. B. Cramer, of Rocketdyne. Approaching the problem on rigid thermodynamic grounds, the authors considered effects on a high-burning-rate propellant of ignition in small cylindrical cavities unavoidably present in the propellant.

Crux of the difficulty is the disputed ability of a flame to enter and hold in such a cavity, thus producing pressure that would propagate the minute crack and cause increasingly greater structural damage until the motor is rapidly destroyed. The ability of flame to enter such a small pore was disputed, but data is not yet sufficient to prove either case.

The possibility that flame might enter and cause structural damage through such pores would present a runaway burning-rate problem of first magnitude; there is now no way to completely prevent such pores from occurring in rocket motors.

Cramer pointed out that there is every reason to expect a high incidence of 200 to 400 micron flaws in the best of conventionally processed propellant, which do not present problems at burning rates now in use. However, when burning rates reach the range of five to 20 inches per second, flaws of this magnitude could be disastrous.

• **Lithium as propellant**—"After many years of idle discussion, lithium is finally receiving the degree of research activity which is warranted on the basis of its unique combination of physical, chemical, and thermodynamic properties," said M. C. Hardin and A. I. Masters, of Allison Division, General Motors, who presented encouraging research data to back up the statement.



SCHEMATIC shows how Allison system used liquid lithium as rocket fuel.

The authors presented results of studies showing lithium to have application as:

—High-energy solid-propellant additive

—Storable liquid bipropellant additive

—Fuel for operation in high temperature environments

—Fuel for hybrid rocket engine

—Propellant for a nuclear or chemical-nuclear rockets

—Working fluid for cooling, heat transfer, heat storage, or other similar applications.

Like other papers presented at the meeting, the GM report cited the lack of complete research data. Additional development, the authors said, will depend on complete determination of thermodynamic data for the lithium reaction products and a more detailed examination of the problems involved in handling the metal in its various states.

Describing rocket engine tests with the metal as a liquid fuel and hydrogen peroxide as oxidizer, the authors say uses of liquid lithium as a fuel in specialized rocket applications is feasible.

• **Rocket test setup**—The laboratory setup at Allison consisted of a 200-lb.-thrust motor using liquid lithium heated to 500°F and injected into a gas stream of decomposed hydrogen peroxide. Since lithium is more readily han-

dled in the liquid form than most metals, there was no need for a slurry carrier, solid propellant binder or other techniques.

The uncooled motor was kept as small and simple as possible, yet large enough to obtain valid data. Operating time was less than ten seconds.

Allison showed some concern over burnout of combustion chambers during firing; this turned out to be justified. Of two rocket motors used, one of .35 inches diameter and a second of 3.50 inches diameter, the smaller one was limited to runs of less than three seconds because of chamber burnout or extreme nozzle erosion.

A total of 36 bipropellant runs were made during the Allison study, which used a theoretical I_{sp} of 260 at 500 psia chamber pressure. The engine accordingly was made with a throat area of 0.269 square inch, and a lithium flow rate of 0.25 lb./sec with hydrogen peroxide flow of 0.51 lb./sec were established.

The 90% hydrogen peroxide was injected into the motor through a catalytic decomposition chamber, where it was broken down into oxygen and water vapor at about 1360°F. A variety of lithium injectors were tested, using a single point injection into the center of the H_2O_2 stream.

Combustion chambers segments of various lengths provided characteristic lengths in a range from 50 to 300 inches.

Nozzle materials tested included copper, graphite and plasma-sprayed tungsten over graphite. A water cooled nozzle was used at one point late in the program.

Allison said 21 runs were made with the smaller engine, and all nozzles showed extreme erosion. A larger chamber was designed on the theory that greater flexibility of injector design would not present a danger of lithium impingement, and in addition a larger chamber would reduce gas velocity at the exhaust nozzle entrance.

Moving to the larger diameter chamber practically eliminated chamber burnout and reduced nozzle erosion, although the latter remained a problem. With tungsten-coated graphite nozzles in the 3.50-inch chamber, nozzle erosion was reduced to a three to ten percent diameter increase in three to seven second runs.

Fuel/oxidizer ratios were varied widely during the 36 runs in both chambers, the two propellants being hypergolic. A pyrophoric characteristic of the vaporized liquid lithium was also apparent during the studies.

Stable combustion was apparent throughout the tests, with high frequency oscillations limited to one to five psi amplitude at 800 to 1000 cps. ⌗

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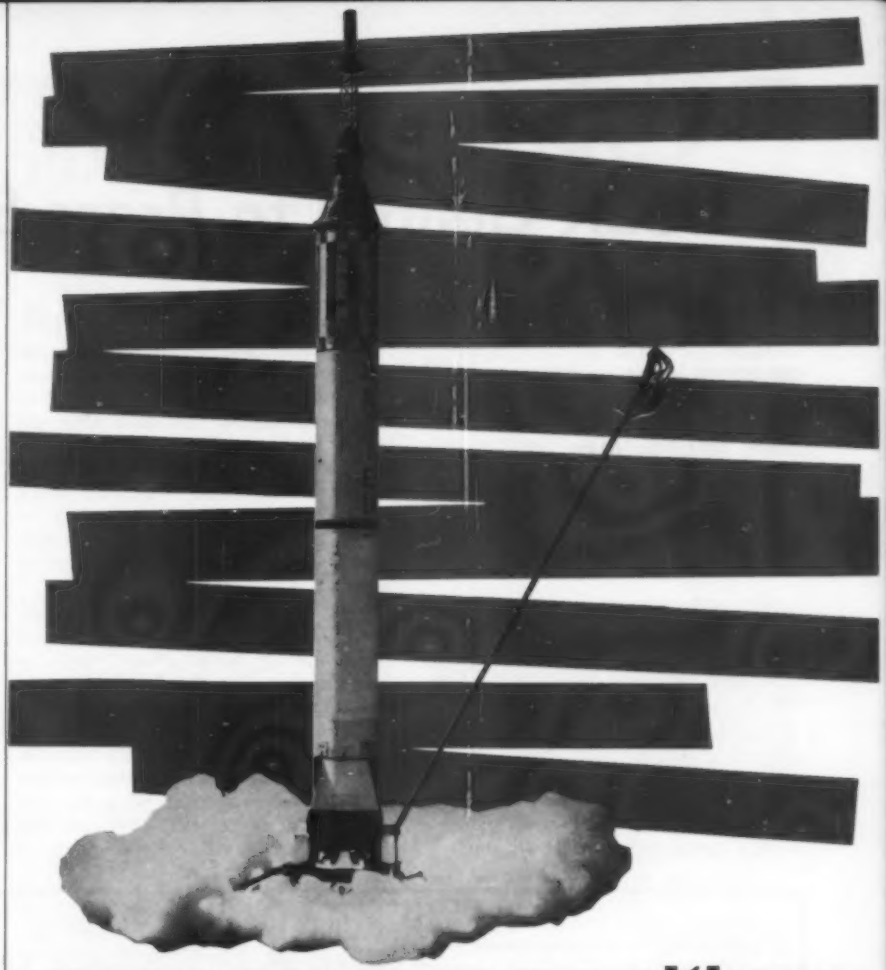

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Military leader . . .

USSR Geared to Press Space Lead

'Super agency' for research appears to have new overall authority; MIT's Trilling outlines implications

THE SOVIETS have formed a powerful "super agency" for research, apparently to further exploit their space accomplishments.

Set up only a few days after the USSR announced its manned spaceflight, the State Committee for Coordination of Scientific Research Work apparently will override all existing research groups and committees including the influential Soviety Academy of Sciences.

The move was interpreted by Prof. Leon Trilling, Massachusetts Institute of Technology Soviet affairs expert, as an indication that the Russians would concentrate on the potential application of their research projects—lifting applied research far above basic research.

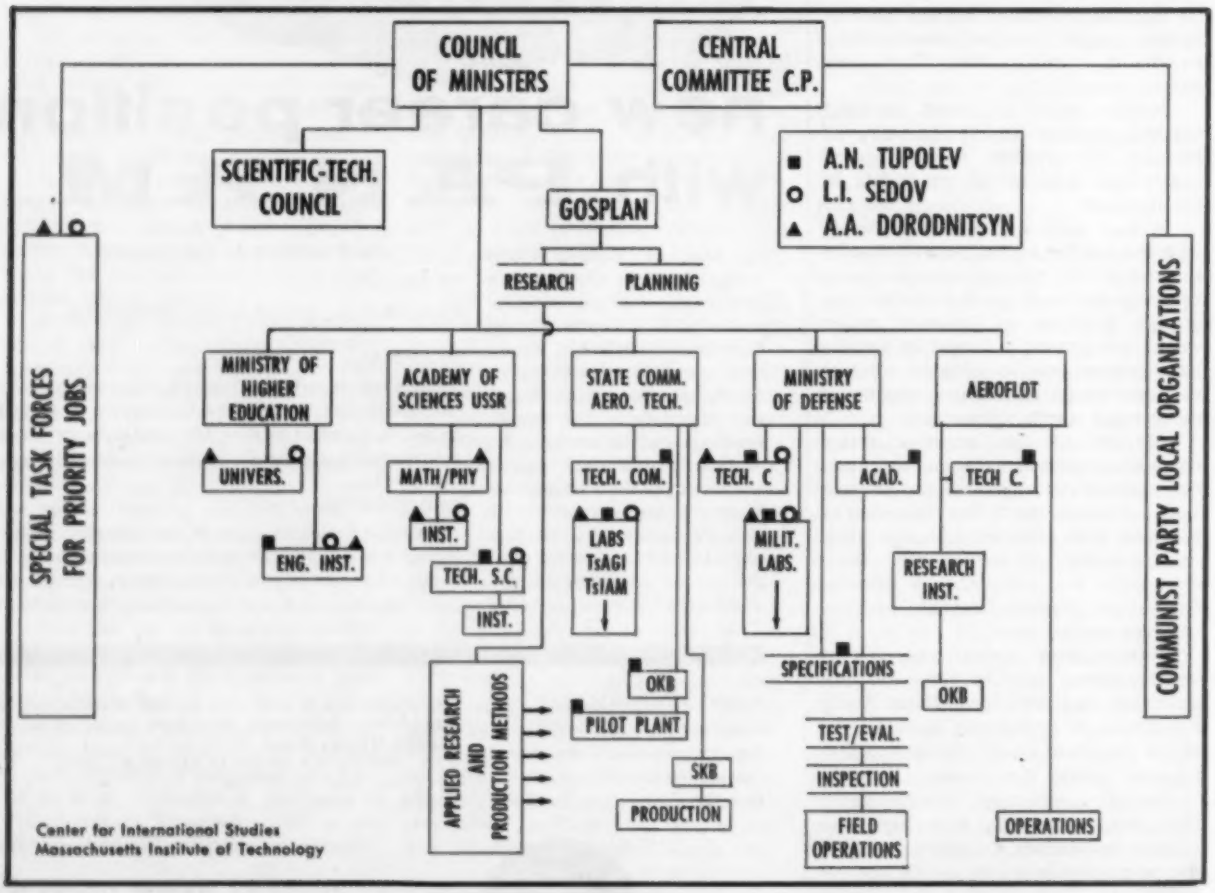
"We would not say that they are upgrading their scientific effort by this move. It gives the definite impression that they are going to push heavily to exploit their space accomplishment and the state of the art in astronautics," Prof. Trilling told M/R.

Head of the new committee is a military airframe man—not a scientist. Lt. Gen. Mikhail V. Khrunichev was head of Soviet airplane production and First Deputy Chairman of the State Planning Committee (GOSPLAN). The new committee apparently will have equal stature to the GOSPLAN and report only to the Soviet Council of Ministers (see chart).

Prof. Trilling said it probably would assimilate the Scientific-Technical Council. The Ministry of Higher Education, the Academy of Sciences, and the State Committee on Aerospace Technology and a number of technical committees will report directly to the new committee.

Recent reports from Moscow indicate that the Academy of Sciences has

BELOW: *Soviet Aeronautics R&D. The new super agency probably replaces Scien.-Tech. Council and overrides all others.*



3M MATERIALS MEMO

News of materials for the aerospace industry – selected from the 27,000 products of the 3M Company

■ STOP SCRATCHING!

Sometimes a good scratch in the right spot at the right time can be quite a satisfying experience. And scratching is important in the missile world, too, in a negative sort of way. Most any significant scratch is taboo on the birds' tender skins. Careful handling alone won't avoid the problem, either. Until levitation becomes practical, the birds simply must be supported and handled during fabrication.

There is a solution, though, and a very convenient one at that. It's the new "SCOTCH" BRAND Heavy Duty Protective Tape, Y-9013. Developed by our INDUSTRIAL TAPE DIVISION, Y-9013 offers both high abrasion and penetration resistance along with weather resistance. Even 400 hours in a weatherometer fail to degrade it or interfere with its easy and clean removal. With 9013's ability to stretch up to 25% lengthwise and 30% crosswise, conformability to contoured surfaces is excellent.

This 17 mil thick tape owes most of this **abuse** resistance to its heavy rubber impregnated paper backing. Of course, the long aging adhesive complements it well by providing stain resistance and **no** adhesive transfer (even after 9 months outdoor exposure). Whether your protection problems involve metals or plastic, check the coupon at right to learn how Y-9013 can help you wrap them up.

■ PIPE DREAMS

Trying to find an effective way of protecting pipe hardware against corrosion? Here's a system which literally lets you give the problems the air—by **spraying** on protection with our ELECTRICAL PRODUCTS DIVISION's new "Scotchkote" Brand No. 101. A 100% epoxy resin "Scotchkote" No. 101 is supplied in a one-part powder form, ready for immediate use. There's no need for compounding or hazardous solvents. Application is merely a matter of preheating the metal fitting to about 400°F and spraying the "Scotchkote" **as a powder** with a flocking gun. It flows on contact to form a uniform, porcelain-like coating, and cures in less than 60 seconds. And since the heat's in the part and not in the resin; the unused particles of No. 101 can easily be recovered and reused.

Once in place, "Scotchkote" No. 101 stays put. It won't flow under pressure or heating as thermoplastics do. Provides corrosion protection up to 250°F; and hydrocarbons, fuel oil, gasoline and many other chemicals don't bother it a bit. It combines high impact strength and high adhesion (over 3000 psi on steel) to resist damage, even under rough handling. For the full story, check the box below.

■ EVERY OUNCE COUNTS

A few months ago we told you how the high strength/weight ratio of "Scotchply" Brand Reinforced Plastic could be used in solid propellant rocket motor cases. Let's not forget, however, that it's just as important on many small items. Take, for example, a simple thing like a machine bolt. Although weight savings may seem insignificant on a single bolt, remember that some birds are literally "buckets of bolts."

The way to make such fittings is with "Scotchply" 1100 High Strength Molding Compound. Grumman Aircraft for one has used it effectively to make machine bolts that are 20% lighter than aluminum . . . twice as strong as those made from other molding compounds. Tensile strength of the molded bolts was 22,000 psi and the double shear strength was 22,000 psi.

"Scotchply" 1100 is both an interesting and convenient material. In its uncured form, it's a series of free flowing, uncured ½" glass fibers uniformly impregnated with epoxy resin (35% by weight). Required press temperature for molding is about 330°F. Pressures for compression molding range from 250 to 2500 psi and for transfer molding, 1000 to 10,000 psi.

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been instructed to concentrate on the most promising and rapidly developing branches of sciences, such as physical and humanitarian sciences. Another move will be to speed up the gap between research and production, and the introduction of new scientific discoveries into the economy.

Other elements of the Soviet research organization were described by Prof. Trilling to the Institute of Aerospace Sciences. He listed the five guiding principles of Soviet research as:

1) Setting up of strict priorities insuring the allocation of resources and personnel to the most vital projects. While policy-makers are technically literate and alert to the potential of applied science, they do not accept extensive advice from scientists on which things should be done—only how something should be done.

2) Separate functions are maintained for research, development and production throughout the entire space program. Scientists are usually trained at universities, research engineers and designers at engineering institutes (both civilian and military), and engineers at other engineering institutes. This "packing order" was originally set up in order to concentrate scarce available teaching and design talent in a few central locations.

3) Single responsibility, though not as rigid now as it was in earlier days, is still dominant in the high-priority programs. The method selects the most capable managers, puts them into top slots in vital programs, and consequently sacrifices emphasis on other areas of endeavor.

4) Special task forces for special jobs. A corollary of the concept of single responsibility, this approach enables the top man to put together a team for which he is ultimately responsible. Since R&D is treated as in instrument of national policy, its objectives are specific and concrete.

Much research and development, says Dr. Trilling, resembles a dash runner trying to run a mile race. R&D is often programed as a sequence of short and medium range tasks for fulfilling specific immediate requirements.

5) A multiple-hat system assigning a number of concurrent administrative responsibilities to each leading scientist concentrates the management of large segments of the overall R&D effort in a small group of men (see chart).

• **Decision-making pattern**—In detailing the route which high-level decisions must travel before becoming action, Dr. Trilling pointed out:

The Communist Party of the Soviet Union (CPSU), has an administrative structure independent of the official government administration. It defines the values underlying policy decisions and its top personnel overlap the government. Its local organizations provide alternate channels of communication and command.

The Academy of Sciences has the statutory responsibility of doing the Soviet Union's basic research in its various institutes and laboratories. The Academy includes in its membership scholars, engineers, and military officers with technical backgrounds. Dr. Trilling points out that these last members have increased markedly in number in the last decade and there are now 20 technical officers of flag rank among the 31 academicians in the Department of Technical Sciences.

A particularly important triple role is played by the Zhukovskii Military Air Engineering Academy, which trains officers for the technical branch of the Soviet Air Force, giving them a five-year military engineering program. In addition, it gives a military background to designers, and almost all senior Soviet aircraft and missile designers currently active have attended the academy for at least two years, including some of whom have taken the full program and graduated (Yakovlev, Mikoyan, Gurevich, Ilyushin and others).

Its third function is that of updating in the technical fields all those field officers who appear to have special promise for future high command. As an illustration of this, the ten present ranking generals of the Soviet Air Force took a two-year course at the academy when they held the rank of major or colonel and were of age 33 to 37.

The Zhukovskii Air Academy school badge singles out and unites the entire policy-making community of the aerospace development program.

• **Program organization**—Aerospace research and development, as shown by the organizational chart, is divided among a number of permanent agencies directly responsible to the highest group of authority in the USSR, the Council of Ministers. These permanent agencies include the Academy of Sciences, the State Committee on Air Technology (formerly the Ministry of Aircraft Production) and the Ministry of Defense.

Note the multiple-hat assignments of the three key scientists, A. N. Tupolev, L. I. Sedov and A. A. Dorodnitsyn.

In addition to the three primary agencies the Ministry of Higher Education and Aeroflot, the state airline, are also on an organizational par. The Ministry of Higher Education is responsible for research done at university and engineering-school levels.

Special task forces, somewhat akin to the U.S. wartime Manhattan Project, are entrusted with overriding authority to push through vital programs.

The Interdepartmental Commission for Interplanetary Travel which was established in 1954 may be all or part of such a task force in missiles and space vehicles. It includes 27 members, of whom 14 are scientists (6 astronomers, 1 geophysicist, 2 physicists, 1 chemist, 3 theoretical aerodynamicists, 1 designer of computer systems); 9 are engineers (4 propulsion, 3 electronics and guidance, and 2 in telemetry and data reduction). In addition to these, three are generals of artillery and air forces, and another is an administrative aid.

A few of these members are drawn directly from Academy ranks, while others are designers on staffs of different ministries involved.

While the commission itself does no research, it does take part in fund allocation and its individual members supervise parts of an overall program, each member working within his own jurisdiction and in a coordinating role.

According to Dr. F. J. Krieger of the RAND Corp., it was also in 1954 that the Presidium of the Academy of Sciences established the K. E. Tsiolkovsky Gold Medal for outstanding work in interplanetary communications, to be awarded every three years beginning in 1957. Although no recipient for this medal has yet been announced, several Lenin prizes have been awarded for contributions to space projects.

The Interdepartmental Commission

Distribution of Personnel

	USSR	US
Basic and applied research	140,000	60,000
Development	100,000	300,000
Design	170,000	100,000
Production	260,000	200,000

Soviet Long-Range Space Program*

Phase I—Earth satellites

- *Surveillance satellites in polar orbit with optical and television equipment*
- *Space stations at high altitudes*

Phase II—Exploration of the moon

- *Ranges from initial three Luniks to plan for sending two manned vehicles at the same time. Supplies and fuel would be deposited on moon in advance for use by landing party during stay and for return.*

Phase III—Interplanetary travel

- *Reconnaissance rockets to each planet*
- *Artificial satellites of the sun*

* *Phases are concurrent*

on Interplanetary Communications joined the International Astronautical Federation in 1957.

In December, 1956, 13 Soviet scientists attended the International Congress on Rockets and Guided Missiles in Paris. Papers presented there already showed the surprising progress the Soviets had made.

• **Academy of Sciences**—Divided into eight departments, the Academy of Sciences has two specific departments of interest to the space program.

The Department of Mathematics-Physics and the Department of Technical Sciences each control a number of institutes engaged in research. An example is the Steklov Mathematical Institute whose theoretical mechanics division is under L. I. Sedov; or the computing center, which is under A. A. Dorodnitsyn.

Altogether, Dr. Trilling states, the Soviet Academy of Sciences controls—directly—about 12% of the entire USSR research and development budget.

Size and scope of the numerous academy research institutes is widely variable. At one extreme is the Institute of Automatics and Telemechanics, with a staff of more than 1000, of which 300 are scientists. This group does fundamental research on automatic control systems, data processing and related fields. It builds breadboard models of new devices, which are then passed along for development elsewhere.

At the small end of the spectrum, the Mechanics Institute has a total staff of about 200, of whom 80 are scientific personnel. A breakdown of this group shows a Solid Mechanics Department, with further reduction into sections of elasticity under Sokolovski; plasticity under Ilyushin; construction mechanics and wave propagation in solids under Rakhmatulin and a general mechanics section to handle stability of motion, theory of oscillations, gyroscopes, automatic controls, etc.

The Fluid Mechanics Department of the same institute has sections on hydrodynamics and filtration problems, high-speed gas dynamics, and rarefied gas flows. In 1958 this Institute as a whole had a modest structural lab and a "Strela" digital computing machine. Within the past two years, it has built a shock tube and a small hypersonic wind tunnel.

The research programs of these institutes, Dr. Trilling said, are formulated as broad five-year plans and also as detailed yearly plans. The plan includes a combination of problems assigned from above and of other problems generated within the institute.

It is believed the more creative staff members in these organizations are fairly free to do what they want, while the rest are assigned to specific tasks suggested by outside agencies.

• **Other research groups**—Universities also handle much basic research in the aerospace field, particularly through the Mechanics Faculty. Included in this effort are graduate theses and some sponsored research. Moscow and Leningrad Universities are especially active in this work.

Additionally, special work can be carried out by any government agency on various projects. When the photographs of the back side of the moon were completed, considerable work was required to eliminate distortions and impediments, as well as ascertain the actual formations on the lunar surface.

Dr. Krieger said the photos were processed by obtaining three copies of the negatives, which were then sent to three different scientific organizations, the Academy of Science's main astronomical Observatory at Pulkovo, the Shternberg State Astronomical Institute in Moscow and the Astronomical Observatory of Kharkov State University.

Each of these organizations studied the photos separately, and the results were compared. The more detailed processing was carried out in Moscow in collaboration with the Central Research Institute of Geodesy, Aerial Photography and Cartography.

Some basic research, and considerable applied research and development is carried on in a series of special institutes administered by the State Committee on Aircraft Technology. Other similar organizations are supported by the Ministry of Defense and the Ministry of Defense Production.

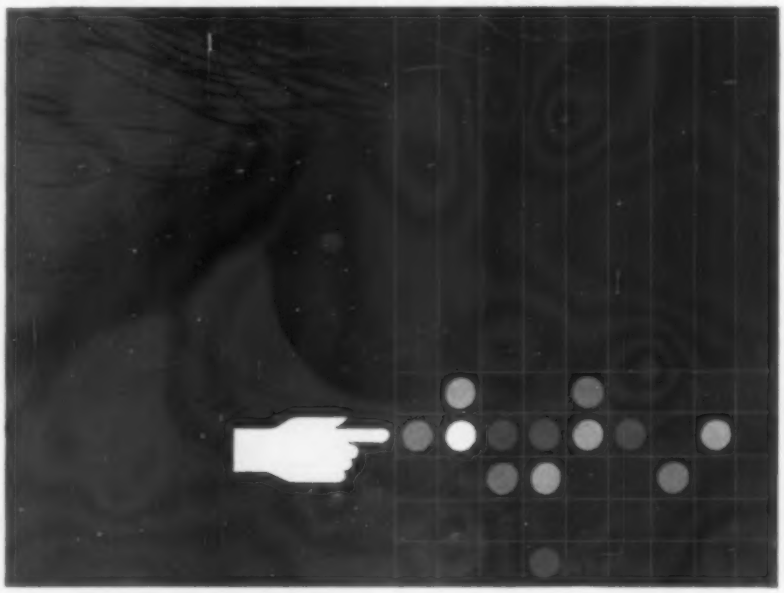
These include various large laboratory complexes such as TsAGI, TsIAM, VIAM, and LII, which form a network comparable in size and scope of activity to the research centers of NASA.

TsAGI specializes in hydrodynamics, aerodynamics, stability, control, and related fields. TsIAM specializes in propulsion. VIAM's work centers around airborne materials, fuels and lubricants. LII is the country's flight test center.

The facilities comprising these laboratories are not very well known, and Dr. Trilling points out that even less is known about the 60 or more laboratories specifically devoted to development of airborne electronics, rockets and advanced power plants.

Reliable estimates, however, place the working staffs of each of these major complexes at about 400 scientists each on the average, with supporting

(Continued on page 48)



THINK, ACT! How will crews of aerospace vehicles perform under long periods of stress and confinement? Lockheed/Georgia finds accurate answers in the crew mockup section of its Behavioral Research Lab – just one of the many capabilities of its highly qualified Human Factors Research Group. LOCKHEED/GEORGIA

Marietta, Georgia

Adhesive Takes High Heat and Shock

Space uses envisioned for cement which bonds glass, ceramics and metals and has high radiation resistance

DEVELOPMENT problems with high-temperature thermal converters have produced a dividend in the formulation of a new high-temperature adhesive—capable of a maximum service temperature of 5300°F.

American Thermocatalytic Corp., Mineola, N.Y., discovered that no known high-temperature adhesive would meet the requirements of the radiant reactors as used in its combustion process.

A research program was initiated to find an adhesive having an extremely low coefficient of expansion and excellent bonding characteristics to ceramics, refractories, quartz and metals. It would also have to withstand continuous service temperatures over 4000°F and repeated, severe thermal shock.

The investigation resulted in a family of cements designated "Astroceram."

K. W. Cornely, ATC's chief chemist, says the coefficient of thermal expansion for the cements is 5×10^{-9} in./°F. Their most outstanding properties are resistance to high temperatures and heat shock. The adhesives do not react nor cause reactions when in contact with metals and ceramics.

Cornely believes this special inertness is due to the formation of "saturated" compounds. Astroceram is essentially a 2 component phase system. Thus one component is saturated with regard to the second component in a ceramic sense.

• **Startling properties**—The actual composition of the cement is proprietary, but it is known that one component is based on the oxides and silicates in the Group IV elements of the Periodic Table.

Other physical properties include a thermal neutron cross-section ranging from 20 to 30 Barns and a thermal conductivity of the order of 23.2 Btu/hr. ($ft.^2$) (°F/in.).

Tests of the mechanical properties showed that Astroceram cements possess a hardness of 8-9 Mohs, tensile strengths from 10,000 to 15,000 psi and compressive strengths from 80,000 to 150,000 psi. Modulus of rupture is close to 23,000 pis and porosity between 0 and 0.2%.

The dielectric strength of the cements is 200-300 volt/mil, with dielectric constant of approximately 9.0 at 60 cps and from 7 to 9 at 10^6 cps. Arc resistance tests resulted in a showing of over 500 seconds. Volume resistivity is $10^{13} - 10^{15}$ ohms/cm.

Chemically, the cements are soluble in hydrofluoric acid but only slowly soluble in boiling concentrated sulfuric acid. They are insoluble in hydrochloric, nitric, phosphoric and sulfuric acids at room temperature.

At temperatures over 1800°F, the cements are resistant to carbon monoxide, carbon dioxide, water, oxygen and hydrocarbons. Additional resistance to sulfur and arsenic at 1800°F has been confirmed. The adhesives react with carbon at temperatures exceeding 3000°F. Reactor work has demonstrated the excellent resistance to radiation.

• **Missile/space applications**—A number of manufacturers have been successfully using the cements in the casting of welding and brazing fixtures, and crucibles. Glass, quartz, zirconia, alumina, refractories, ceramics and metals have been bonded. Astroceram adheres so tenaciously to aluminum, says Cornely, that it is possible to melt away the metal, leaving the cement intact.

ASTROCERAM wire withstands 3500°F exposure; uncoated Nichrome wire melts.

The cement can be used as a dielectric for capacitors, a potting compound for electronic components, in sealing feed-through insulators and as a mortar for fire-brick in high-temperature furnaces. Fire-brick can be upgraded by a surface coating to withstand extreme temperatures.

Thermocouples have been encapsulated with Astroceram, in place of ceramic and metal sheaths, resulting in improved heat transfer. In this connection, it has been employed in wire casing and wire end seals.

Boeing, NASA, AEC, Lawrence Radiation Labs, Chance Vought and others are investigating the adhesive for a host of applications. It is being evaluated to determine its adaptability for the manufacture of nose cones.

The firm has two basic types of cement available. One can be air-dried and has a service temperature around 4300°F. The second must be fired to achieve a bond and can be used up to 5300°F.

Recent additions to these basic compound types include two low-porosity cements intended for vacuum sealing purposes. ATC chemists are currently developing dry powder mixes, pre-coats and compounds possessing higher coefficients of thermal expansion and covering a broader range of applications. ⌗

Lockheed Researchers Find Low-Energy Neutron Source

LOW-ENERGY accelerators will produce a useful amount of neutrons through a technique developed by nuclear physicists at Lockheed's Missile and Space Division.

Previously, the only source was the more costly high-energy accelerators. The Lockheed scientists can now produce neutrons in the 8-11 million electron volt range by bombarding C^{14} with deuterons accelerated in a conventional 3-million-electron-volt Van de Graaff generator.

Besides being useful as a lab source of neutrons, the C^{14} deuteron stripping reaction is of interest in theoretical nuclear physics. ⌗

British Report on Wide Range Of Research

Universities, government agencies are cooperating in rocket, satellite, tracking experiments and basic study

by Anthony Vandyk

FLORENCE, ITALY—Great Britain is experimenting in vertical sounding rockets, satellites, tracking and data recovery, and carrying on theoretical studies as part of its continuing space research program.

A progress report on the program was given at the COSPAR meeting here this month.

The general overseeing of the program's scientific content is the responsibility of the British National Committee on Space Research. This Committee reports to the Council of the Royal Society, and advises the Minister for Science through the Space Research Steering Group.

Facilities for carrying British experimental apparatus in earth satellites are being provided by the U.S. National Aeronautics and Space Administration. A start has been made in collaborative rocket experiments with both Canadian and French scientists.

Vertical sounding rockets are supplied for the program by the Ministry of Aviation, and launched in Australia by arrangement with the Australian Department of Supply.

• **Tracking and data recovery**—The British have continued active in tracking of earth satellites and space probes. At the Nuffield Radio Astronomy Laboratories, Jodrell Bank, the 250-ft. radio telescope equipment has been used, in cooperation with NASA, to track the *Pioneer* series of space probes.

Radio tracking of satellites using interferometer systems is carried out by the Radio Research Station, Slough. With the help of NASA, a Minitrack station has been installed at the station and is now an operational part of the worldwide chain. The British Broadcasting Corporation continues to record telemetry signals and other features of the radio transmissions from a few chosen earth satellites.

The need for optical tracking of high accuracy is widely recognized, the British report says, but is difficult to meet in the English climate. An attempt to avoid this limitation has been made by installing optical tracking stations at the Royal Observatory, Edinburgh, and on the island of Malta, where the station is controlled by the British Meteorological Office.

One of the recognized shortcomings of present-day precision optical tracking equipment is that it is expensive both to make and to operate, or has severe limitations in accuracy and sensitivity. A number of groups in the U.K. are working towards designs which promise to overcome these difficulties. Amongst the techniques being developed are a photo-electric method at University College, London, and the use of image intensifiers at Imperial College, London. It is hoped in this latter method to take advantage of the much greater quantum efficiency of photo-cathodes compared with the human eye and photographic emulsions. Other developments in optical tracking equipment include work at the Royal Radar Establishment on Schmidt cameras, and at the University College of Wales on other forms of special cameras.

• **Scientific experiments**—Experiments recently carried out, or in an advanced stage of planning, cover a wide range of interests, and are listed below under subject headings.

• **Atmospheric structure and composition**—The atmospheric temperature, pressure, density and winds up to 55 miles altitude are being investigated with the rocket grenade method. At regular intervals grenades are ejected normal to the rocket trajectory to explode some distance away. Recently, considerable use has been made of the luminous glows that follow the grenade bursts above 60 miles, persisting for many minutes. It is likely that the glow is a photo-chemical effect arising from reaction with atomic oxygen. The changing shape and size of the glow makes it possible to estimate diffusion coefficients and local wind velocities.

It is planned to extend the altitude at which density determinations from rockets are made by tracking a light balloon ejected from the rocket. Wind and temperature measurements using the grenade method will be extended so that a systematic study of diurnal and seasonal variations become possible. This part of the scientific program is largely the responsibility of University College, London, and the British Meteorological Office.

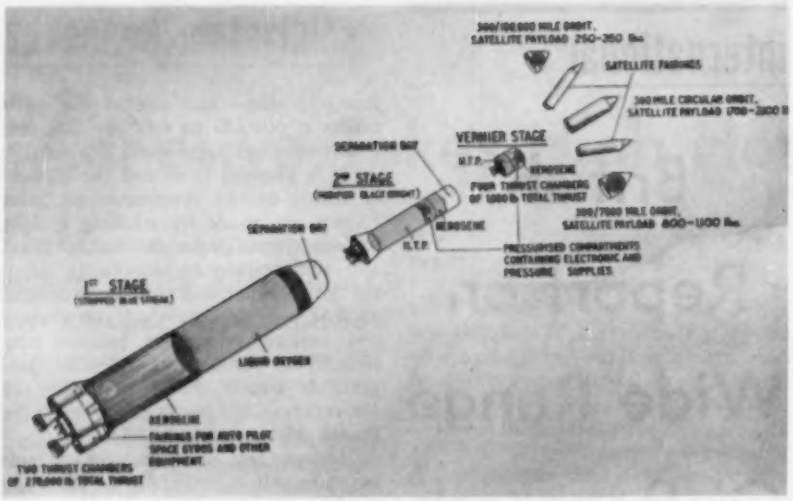
Independent measurements of temperature, winds and diffusion rates are made by a group from the University of Belfast, using the technique of sodium ejection from rockets. Photographs of interference fringes have been obtained from sodium trails with a Fabry-Perot interferometer.

The Belfast group are also studying airglow characteristics and plan to measure the heights of the airglow by carrying, in *Skylark* rockets, photometers sensitive to various airglow radiations.

A substantial part of the British effort concerns the electrical state of the atmosphere and its relation to the radiations believed to be mainly responsible for the ionosphere. Experimental measurements of electron density using a Langmuir probe type of technique (University College, London) and of electron density using a dielectric measurement type of technique (University of Birmingham) have been made from *Skylarks*. Observations on the positive ion content of the ionosphere have been made with rockets by the same two groups, using a Langmuir type probe and a time-of-flight mass spectrometer respectively. It has been confirmed that NO^+ is a dominant ion.

A logical extension from this rocket-borne set of experiments to satellite-borne experiments has been made possible by the cooperation of NASA, which is providing a *Scout* satellite (International Ionosphere Satellite *S-51*) for the British program. It is planned to use this satellite to measure electron density by the two methods mentioned above, as well as to measure electron temperature and the positive ion temperature and mass spectrum. At the same time, measurements of solar radiation in the 3-13 Å X-ray band and around the 1216 Å ultraviolet band will be made.

Analytical studies are in progress both at the Royal Aircraft Establishment and at University College, London, on the determination of air den-



European Space Rocket Proposal

RECENT DESIGN proposed by British for adoption by members of the Western European "Space Club." It would use a stripped-down Blue Streak as first stage, and a modified Black Knight as second stage. France earlier offered to make second stage.

sity from satellite orbits, and on the large variations of air density under various conditions. For instance, the great differences in air density between day and night at 300-450 miles have been investigated in detail, and the decrease in density since the sunspot maximum of 1957-58 has been traced.

The Department of Meteorology of Imperial College, London, are studying upper-atmosphere winds by obtaining radar tracking observations of bundles of resonant dipoles ("windows") released from *Skylark* rockets in Australia. Observations have been obtained in the altitude band from 20 to 40 miles.

The Meteorological Office plans to use small rockets launched from sites in the British Isles to raise the present radio-sonde ceiling of about 20 to 40 miles in the first place, and later to 60 miles.

The Meteorological Office are also planning to examine the vertical distribution of ozone in the atmosphere by measuring the absorption of solar radiation across the Huggins band. A rocket-borne experiment is to be flown shortly in Australia, and it is hoped to mount a similar experiment in a suitable satellite.

Finally, radiation studies of the atmosphere are made from a theoretical and experimental point of view, at Imperial College.

• **Radio propagation and the Ionosphere**—The ionosphere is being studied through methods involving radio propagation observations from both rockets and satellites. The University of Wales, with the Royal Aircraft Establishment, have successfully carried out C.W. Doppler experiments using a *Skylark*, and plans are proceeding for a pulse radio propagation experiment.

The Radio Research Station and the University of Sheffield are undertaking an experiment in which the nature of the wave field set up above a long-wave transmitter (200 kc/s) is explored by means of apparatus in a rocket. Deductions will be made about the electron distribution in the D region.

At the University of Manchester, Jodrell Bank, ionospheric studies have been carried out by observations of the transmissions from several satellites. In particular, during most of 1960, the 108 Mc/s radiation from *Vanguard 1* was examined for Faraday rotation. Irregularities of several percent in the total ionization, with a size of several hundred kilometers, have been revealed. A joint study with several other European stations of scintillations in the transmissions from *Sputnik III* has also been made.

An Admiralty station has obtained extensive recordings of the frequencies of signals received simultaneously from *Sputnik III* at three widely separated stations. Analysis of this data is expected to yield ionospheric information of great interest.

• **Geomagnetism**—In the Geophysics Department of Imperial College, London, possible techniques for exploring the geomagnetic field from rockets and satellites are being studied. It is planned to perform experiments using *Skylark* to carry a proton precession magnetometer.

• **Geodesy**—At the Royal Aircraft Establishment, satellite orbital theory has been extended in two ways. First, a theory has been developed which provides analytical expressions for the effect of aerodynamic forces on orbits in an oblate rotating atmosphere. Second, a fuller theory for the effect of solar and lunar perturbations, including solar radiation pressure, has been formulated.

These, and earlier theories, have been applied to actual orbits to determine the earth's gravitational field. New and better values have been obtained for the coefficients of the second, fourth and sixth harmonics in the earth's gravitational potential.

• **Micrometeorite studies**—The Queen's University of Belfast are making micrometeorite studies by using the microphone detector type of equipment in *Skylark*. These operate successfully in flight and impact records have been obtained.

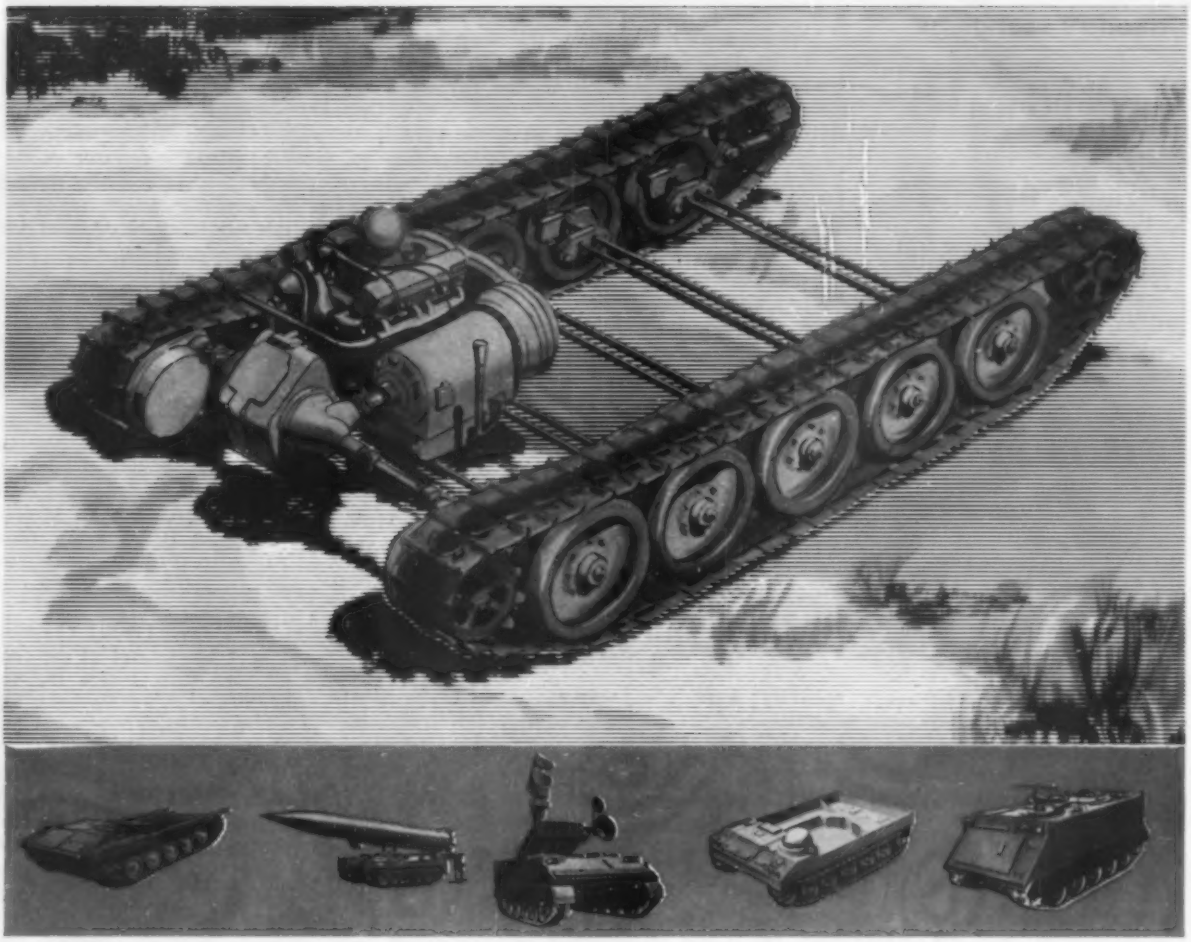
Micrometeorite studies using a different instrument technique are in progress at the Jodrell Bank Station of Manchester University; *Skylark* rockets are to carry the detectors, consisting of thin aluminum foils in which holes are formed by impacting particles. The holes are scanned by sunlight, and the transmitted light pulses are detected by silicon cells. Calibration holes allow an estimate of micrometeorite size.

• **Cosmic radiation**—In the Physics Department of Imperial College, London, investigations of the relationships between the cosmic ray intensity, solar activity and the structure of the interplanetary magnetic field are continuing. Further theoretical work has been carried out on the behaviour of primary cosmic rays in the geomagnetic field and scale-model experiments are in progress to determine the effects of various field configurations, of both internal and external origin, on cosmic ray threshold rigidities.

The first *Scout* satellite carrying U.K. instruments (International Ionosphere Satellite *S-51*) includes a cosmic ray detector of Imperial College. This detector is intended to have an operational test soon in a high-altitude research rocket in Australia.

At the University of Southampton, it is proposed to develop equipment for rocket and satellite experiments in which the higher energy components of primary cosmic rays will be studied.

• **Electromagnetic radiations and astronomy**—At the Mullard Radio Astronomy Observatory, University of Cambridge, an experiment and suitable equipment are being designed to extend measurements of the spectrum of the radio emission from the galaxy down to frequencies of about 1 Mc/s. The receiver, with a long wire dipole aerial, will be suitable for installation in a satellite. ⁂



STANDARDIZATION CUTS R & D COSTS AND REDUCES MILITARY LOGISTIC BURDEN

Food Machinery and Chemical Corporation, working closely with the Ordnance Tank Automotive Command and the using forces, has put the standardization idea to work.

A prime example is the modern Army's multipurpose vehicle family. Based on the M113, an entire family of vehicles ranging from armored personnel carriers to unarmored missile carriers has been developed that uses the same engine, power train and suspension as interchangeable components. This standardization saves research and development dollars, adds production economy, and eases logistic problems in field operation.

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Canada's 'Longlegs'

(Continued from page 18)

by Canada's National Research Council to investigate cosmic particles and related phenomena.

A beacon transmitter is being built into *Longlegs* for tracking and fixing its location in space.

A command receiver will conserve power by activating the sounder for 12 min. only while over a ground telemetry station. Four nickel cadmium batteries, rechargeable by solar cells, provide the power.

DRTE's *Longlegs* will sound the ionosphere directly below it each time it is activated. Secondary experiments will measure cosmic radio noise intensity and particle energy of cosmic rays.

• **Not competitive**—Comparison of the sounding-at-distance and sampling-the-immediate-environment techniques should provide an exact measure of the free electron density which can be compared with results obtained by other ionosphere sampling (e.g. satellites of *Explorer VIII* class).

This is precisely the information gap which the U.S.-Canada experiment will fill. Both types of measurement need to be made simultaneously for an extended period, however, before enough is understood about the upper atmosphere.

Policy guidelines attributed to NASA, which sponsors both types of satellite research, are said to assure complementary and not competitive experiments.

The Canadian satellite will gather needed information on radio waves which do not penetrate the dense layer of the ionosphere and, as a result, provide no information to the scientists on the ground.

Soundings obtained when the satellite passes the northern auroral zone will be particularly interesting to Canada because of the special communications problems existing in high latitudes and Arctic regions during auroral disturbances. ⌗

British-NASA Probe Set

A second British satellite will be launched in 1963 by a U.S. Scout vehicle.

Scientists from Britain and the U.S. National Aeronautics and Space Administration announced agreement last week on plans for a spacecraft that will measure galactic radio emissions at wavelengths too long to penetrate the earth's atmosphere.

The satellite will also carry instruments to measure vertical distribution of ozone in regions where it is being formed, measure micrometeorite size and number and obtain data on the electrical condition of the upper atmosphere.

It will have an apogee of about 1200 miles and a perigee of 180 miles.

The first British Scout satellite, to be launched in 1962, will be designed for ionosphere measurements.

Space Crash Program?

(Continued from page 16)

questioning that the biggest cut was about $50 million for Project *Apollo*—$42.6 million of research and development money, $5 million for a tracking station and $2½ to 3 million in salaries and expenses for hiring an additional 300 in-house staff for *Apollo* at Space Task Group, Langley Field, Va. STG now has a staff of about 75 working on *Apollo*.

The next biggest cut that emerged from discussions in the Space Committee and the Joint Atomic Energy Committee was $30.5 million from Project *Rover*. The *Rover* cut broke down to $7 million in Atomic Energy Commission operating funds, $8.5 million in NASA R&D money and $15 million of NASA construction money.

At the same time the Joint Committee disclosed that the Kennedy administration has suspended plans for flight test of the *Rover* nuclear rocket pending a new study of the program by a committee chosen by Dr. Jerome Wiesner, Kennedy's chief scientific adviser. However, the review does not interfere with the administration's previously approved relatively modest speed-up of the *Rover* R&D program.

NASA officials outlined for the Space Committee these other items disallowed in the Kennedy review.

—Lunar & planetary programs, $25 million additional for *Mariner B*, a preparatory shot in 1963 designed to test out equipment for a 1964 Mars probe.

—Scientific satellites, $13 million to increase contractor funding on the Orbiting Astronomical Observatory and the Orbiting Geophysical Observatory to make certain that flight target dates are met.

—Meteorological satellites—$12 million for two additional *Tiros* satellites, to make certain that a weather satellite is in orbit all the time until the *Nimbus* satellites are ready to fly.

—Life science programs, $5 million for contract research.

—Support of NASA plant, $4 million.

Altogether, NASA sought $236.49 million additional for R&D, $52.2 million for construction of facilities and $19.5 for salaries and expenses, for a total of $308,191,000, Seamans said.

The additional *Apollo* R&D money would be used for high-speed re-entry tests with *Atlas-Agena B* vehicles and to give the R&D contractor a start earlier in the fiscal year. Under the previously allowed $29 million for *Apollo*, the contract would not be awarded until after the first of the year.

The $5 million tracking station would be added to the *Mercury* network to give the net the capacity for tracking during more than three orbits and would permit long *Mercury* shots in preparation for *Apollo*.

On Project *Rover*, the $15 million construction item would have been for a nuclear rocket testing facility in Nevada. The $7 million for the AEC would have speeded reactor development. The NASA R&D money would expand work performed under the Nerva engine contract, to be awarded in the next month or so.

Rep. Melvin Price (D-Ill), chairman of the R&D subcommittee of the Joint Committee, said that unless the full requests are allowed for *Rover*, it will be impossible to meet the previously announced launching date in 1966-67.

Meanwhile, a committee headed by Harvey Brooks of Harvard University conducted the *Rover* study for Wiesner. Other members of the committee are:

Al Donovan, Aerospace Corp.; Arthur Biehl, Mainhardt-Biehl Associates; Eugene Wigner, Princeton University; William Graham, Rand Corp.; Theodore Merkle, Livermore Laboratory; Stanislaus Ulam, Los Alamos Laboratory; Walter Zinn, Combustion Engineering; and Berndt Matthias, Bell Laboratories.

Other construction requests disallowed by Kennedy, Seamans said, included $17 million for a high-vacuum facility to test new types of propulsion at the Lewis Laboratory in Cleveland and a test stand for the *F-1* liquid rocket at Edwards AFB. ⌗

'Meteor Bumper' Proposed To Shield Space Vehicles

PALM SPRINGS, CALIF.—General Electric engineers report that using a thin outer shield to protect space vehicles against both natural and man-made meteoroids would make it possible to cut the weight of external wall structure by more than half—with no sacrifice in safety.

Robert R. Wallace, J. R. Vinson and Murray Kornhauser of General Electric's Missile and Space Vehicle Department reported on investigation of the "Meteor Bumper" concept at the American Rocket Society Conference on Lifting Re-entry Vehicles.

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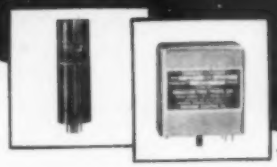
SIZE, 1-3/8" x 1-3/8" x 3/8"

This frequency standard (360 or 400 cy.) is accurate to ± 25 parts per million at 10° to 35°C. The tuning fork is made from Iso-elastic alloy and is approximately 1 inch long. Fork aging has been greatly minimized. Compensation in the circuit provides a minimum rate change throughout the useful life of the power cell (over a year). External power of 1.4 volts at approximately 6 microamperes can also power the unit. An hermetically sealed model, Type 15, is also available.



TYPE 2007

TYPE 15

For more than 20 years, this company has made frequency standards and fork oscillators within the range of 30 to 30,000 cycles for applications where consistent accuracy and rugged dependability are demanded. A few examples are shown and described here.

Some users integrate these units into instruments of their own manufacture. Others rely on our experience and facilities to develop complete operating assemblies to meet their special needs.

You are invited to submit any problems within the area of our activities for study by our engineering staff.

TYPE K-5A FREQUENCY STANDARD

Size, 3½" x 3" x 1¾"
Weight, 1½ lbs.
Frequency: 400 cycles
Accuracy: .03%, −55° to + 71°C
Input: 28V DC ±10%
Output: 400 cy. approx. sq. wave
at 115V into 4000 ohm load (approx. 4W)

TYPE 2007-6 FREQUENCY STANDARD

Transistorized, Silicon type
Size, 1½" dia., x 3½" H., Wt., 7 oz.
Frequencies: 360 to 1000 cy.
Accuracies:
2007-6 ± .02% (−50° to +85°C)
R2007-6 ± .002% (+15° to +35°C)
W2007-6 ± .005% (−65° to +85°C)
Input: 10 to 30V DC at 6 ma.
Output: Multitap, 75 to 100,000 ohms

TYPE 25 PRECISION FORK

Size, ⅝" dia. x 2⅛"
Weight: 2 ounces
Frequencies: 200 to 1000 cy. (specify)
Accuracies:
R-25T and R-25V ± .002% (15° to 35°C)
25T and 25V ± .02% (−65° to 85°C)
For use with tubes or transistors.

TYPE 15 FREQUENCY STANDARD

Similar to Type 10 (illustrated) except with silicon transistor, hermetically sealed and vibration resistant.
Size, 1" x 2" x 2" high
Tolerance, ± .01% from −40°C to + 71°C
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NASA

United Controls Corp., Seattle, from **Lockheed's Missiles and Space Division**, for a programing device to provide the electrical impulse to restart the *Agena* satellite engines. Amount not disclosed.

ITT Federal Laboratories, Fort Wayne, Ind., for design and fabrication of a portion of space-borne weather reconnaissance equipment for *Nimbus* satellite program. Amount not disclosed.

MISCELLANEOUS

$82,000—**Dunn Engineering Corp.**, Cambridge, Mass., from **Lockheed Aircraft Corp.**, for manufacture of system for testing missile and satellite inertial guidance assemblies and their components.

NAVY

$3,227,400—**Sperry Rand Corp.** through **Sperry Piedmont Co.**, Charlottesville, Va., for HK 19 MOD 3A gyro compass equipment.

$2,000,000—**Hycon Manufacturing Co.**, Monrovia, Calif., for automatic test equipment for *Terrier* and *Tartar* missiles.

$1,438,058—**Hickok Electrical Instrument Co.**, Cleveland, for AN/USM-105A oscilloscopes.

$318,346—**Skagit Steel & Iron Works**, Sedro-Woolley, Wash., for missile handling equipment for underway replenishment consisting of structure, machinery and controls.

$171,487—**Ramo-Wooldridge Division of Thompson-Ramo-Wooldridge, Inc.**, Canoga Park, Calif., for design, development, construction and furnishing of one set of digital equipment for use on AN/SLQ-11 passive ranging system.

Erie Pacific Division of Erie Resistor Corp., Hawthorne, Calif., from **Nortronics Division of Northrop Corp.**, for a high-speed, pre-set electronic counter/timer for use in the *Polaris* missile checkout system. Amount not disclosed.

The Garrett Corporation's AiResearch Industrial Division, Los Angeles, follow-on order for high-pressure reducing valves for nine future *Polaris* submarines. Amount not disclosed.

ARMY

$17,656,015—**Bowen-McLaughlin-York, Inc.**, York, Pa., for recovery vehicle, M88, and repair parts.

$1,025,000—**Rohm and Haas Co.**, Philadelphia, for research in the field of solid propellants for rocketry at Redstone Arsenal.

$118,503—**National Electric Division**, Ambridge, Pa., for rocket motor case and nozzle assembly.

$36,789—**Radiation, Inc.**, Melbourne, Fla., for services and materials required for acceleration of *Courier* program.

$37,589—**Malaker Laboratories, Inc.**, Mountainside, N.J., for R&D covering a kinetic study of rocket exhaust gases.

Dresser Electronics, SIE Division, Houston, for feasibility studies of using seismic technologies to determine the position of missile impact locations. Amount not disclosed.

AIR FORCE

$11,600,000—**Douglas Aircraft Co.**, Santa Monica, Calif., for *Genie* air-to-air missiles.

$4,000,000—**Marquardt Corp.**, Van Nuys, Calif., for development of a nuclear ramjet engine, Project *Pluto*.

$1,300,000—**Electronic Communications, Inc.**, St. Petersburg, Fla., from **Burroughs Corp.**, for aerospace ground equipment to be used in ALRI, the airborne extension for *Sage*.

$385,000—**Digital Equipment Corp.**, Maynard, Mass., to design, construct and install a dynamic system simulator.

$149,977—**Aerojet-General Corp.**, Azusa, Calif., for investigation of mechanism of decomposition, combustion and detonation of solids.

$146,084—**University of California**, Berkeley, for research on "Theory of Solids."

$128,325—**Aero-Space Division of Boeing Airplane Co.**, Seattle, for technical data applicable to the *Bomarc* missile. (Two contracts.)

$95,502—**University of Illinois**, Urbana, for research on solid-state phase transformations.

$75,000—**The Bendix Corp.**, Detroit, from **Boeing Airplane Co.**, for nose gear for *Dyna-Soar*.

$73,250—**Calif. Institute of Technology**, Pasadena, for continuation of "Studies of Stellar Compositions and Related Nuclear Processes."

$58,840—**Stevens Institute of Technology**, Hoboken, N.J., for research on "Mechanism and Dynamics of Conical Coaxial Plasma Acceleration."

$53,545—**General Electric Co., Missile and Space Vehicle Dept.**, Philadelphia, for research on "Fundamentals of MHD Flow."

Warner Lewis Co., Division of Fram Corp., Tulsa, Okla., from **Convair Astronautics Division of General Dynamics**, for eight ground support fuel systems for the *COPS-1 Atlas* missile. Amount not disclosed.

Defense Products Division of Fairchild Camera and Instrument Corp., Syosset, N.Y., for study of advanced photographic imaging techniques. Amount not disclosed.

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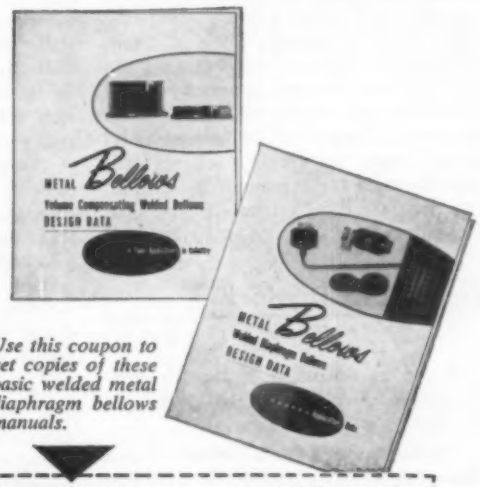

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Propogation Study

(Continued from page 25)

The Telecommunications Planning Committee of the Office of Civil and Defense Mobilization recently reported that there is "inadequate" knowledge of some of the more technical factors affecting ultimate capacities, limitations, and spectrum utilization of space telecommunications. The report cited the need for basic advances in such areas as antenna design, modulation theory, component reliability and propagation effects to develop the potential of space telecommunications.

A recent staff report prepared for the Senate Committee on Aeronautics and Space Sciences said that the potential of satellite communications cannot be properly or adequately exploited until more basic propagation information is obtained and interpreted.

In support of the fund request, NBS cites the dependence of NASA, DOD, FCC, and others on the Bureau for basic technical information on radio propagation. Several satellite telecommunications projects—such as *Advent, Courier, Czar, Echo, Transit*—are being undertaken at present. None of these, however, is directed at obtaining the sort of basic information many scientists feel is needed. As the OCDM panel report said, much of the present effort seems aimed at "trying packages" for satellite radio transmission. "Systems do not depart radically from conventional techniques." ⌗

Launching Drydock

(Continued from page 27)

tion can be reworked to form a communications center, test laboratories and an electronics repair shop.

• **Big enough for a carrier**—For a *Saturn* facility, 1.5 million lb. of thrust and over, the set-up begins to get more complex. Here, the basic unit is a drydock known as an "AFDB." Actually, it's only a drydock section, 250 feet long and able to support 10,000 tons. When a sufficient number of these sections are joined together, they can lift an aircraft carrier out of the water.

These drydocks were built during World War II. A considerable number of them are still in excellent condition.

Norman G. Peil, Pacific Missile Range engineer, points out that each AFDB section has diesel a-c power-generating equipment rated at 750 kva, fresh water evaporators of 200 gph capacity, ballast pumping and control systems, shops and crew facilities. In addition, each AFDB can operate while submerged. Seven AFDB's welded together form a self-sufficient ship-drydocking unit.

For a *Saturn*-type launch, three AFDB sections are proposed—one for the launch platform, another as a service unit, and a third as a blockhouse. An ARD may be used for space vehicle transport and assembly.

Other support vessels include two tugs and also ships for range instrumentation and booster recovery. Existing instrumentation ships can be used downrange for tracking, telemetry and other purposes.

Stevens estimates that it would take about 18 months after the go-ahead to have a mobile launch complex on site and ready for a check-out launch. This is comparable to the time it takes to build a similar facility on land, provided land were available and stateside. Nevertheless, it is a far shorter time and also much less costly than setting up a base on foreign soil. In addition, the political and health hazards are significantly lessened. ⌗

Soviet Research

(Continued from page 39)

staffs numbering about 1200 to 1500 each. Some basic research is conducted in these facilities, usually in cooperation with university or academy-institute projects.

Development and testing of components and prototypes, service testing, backup consulting functions for design teams and operation of a pilot plant are also often under the jurisdiction of such groups.

Altogether, these laboratories account for approximately half the total Soviet R&D budget.

• **Hardware design**—Development and design of specific prototypes is usually handed over to advanced design bureaus (OKB) which are generally named after the senior designer, such as Tupolev's OKB, Yakovlev's OKB, and so on.

Dr. Trilling estimates that a major OKB is comparable in most respects to the design engineering staff of a major U.S. airframe manufacturer. An OKB includes from 600 to 1000 graduate engineers organized along specialty lines such as aerodynamics, structures, dynamic loads, and also along project lines.

In every known case, the OKB is adjacent to a pilot plant where the test prototype is built. Until recently, top-flight design talent being quite scarce, a policy of assigning single projects to single design groups, limiting competition and standardizing solutions of technical problems was in effect throughout the USSR.

• **Soviet space program:** Dr. Krieger quoted Soviet publications on the space program (see box). In addition, he listed certain hardware developments which the Soviets are known to be pushing:

—Creation of large boosters

—Improved stabilization and control systems, and ground launch facilities

—Perfection of high-resolution, multi-channel telemetry for multi-million-mile distances

—Broad development of space medicine.

Most secretive parts of the Soviet space program are the propulsion and guidance systems and techniques. It is these two fields in which they have had the most outstanding successes.

Dr. Krieger also credited the Soviets with apparent superiority in complex automatic control systems:

"The tendency to overengineer a system and the consequent increase in its unreliability have plagued and embarrassed American rocket and missile experts again and again," he said. "The Soviets on the other hand, by stressing fundamental principles and simplicity in design, have apparently developed the happy faculty of making proper executive decisions in the manufacture or use of computer-based control systems and determining which of several automatic control concepts is best."

In a less discouraging light, Dr. Ernest Mayer, Associate Director of Science, National Engineering Science Co., disclosed that Soviet research into the problem of combustion instability doesn't seem any more successful in producing better rocket engines from this standpoint than American research. ⌗

Canoga Electronics Starts Advanced Studies Program

VAN NUYS, CALIF.—Canoga Electronics Corp. has set in motion a program of company-funded research projects to meet future needs for advanced electronics systems.

Designated CAP (for Canoga Advanced Programs), the effort will be directed at developing deep-space tracking, radio astronomy and ballistic missile defense systems.

George H. Nibbe, Canoga's president, said the firm prefers the company-funded approach to the prospect of waiting for "panic-button" programs to come along. He said Canoga will spend its own money to evaluate needs, feasibility, and even—in some cases—physical development.

Formerly a division of Underwood Corp., Canoga Electronics is now independent. Of its total work force of 175, one-third are engineers. The firm has a division at Fort Walton Beach, Fla. ⌗

names in the news

RUDE

HALL

LOMBARD

RICHARDSON

ANSOFF

Arthur H. Rude: Elected chairman of board of Aerojet-General Corp., Azusa, Calif. Other corporate appointments are: **W. E. Zisch,** executive vice president, and **Howard P. Mason,** assistant secretary. **Dan A. Kimball,** president, and all other officers of the company were re-elected.

Willison K. Vance and **Burl H. Ervin:** Promoted to director of applications engineering and chief engineer for systems support, respectively, of Nortronics Division of Northrop Corp., Anaheim, Calif. **E. Forrest Nance** named Western regional director of marketing, and **James B. Meagher** as marketing manager of the marine equipment department.

Homer S. Myers: Elected executive president of Tracerlab, Waltham, Mass., and will continue as general manager of marketing. Myers was one of the group who founded Tracerlab in 1946.

Jack Kuhner: Named vice president in charge of administration, and **H. Edward White** named director of industrial relations of Hoffman Electronics Corp., Los Angeles. Other appointments are: **Capt. Will I. Bull (USN, Ret.)** general manager of the Military Products Division; **Marvin G. Whitney,** director of operations for the Semiconductor Division; and **Theodore S. Hoffman,** director of operations for Semiconductor Division at Evanston, Ill. Hoffman continues as vice president.

John S. Hall: Joins Kidde Aero-Space Division, Walter Kidde & Co., Inc., Belleville, N.J., as manager of manufacturing and procurement. Previously Hall was manager of manufacturing at Gabriel Electronics Division, Millis, Mass.

M. E. Mohr: Vice president of Thompson Ramo Wooldridge, Inc., Canoga Park, Calif., appointed general manager of new Electronic Systems and Engineering group, with **W. M. Jones,** also vice president, as associate general manager.

Maurice Stillwell: Appointed manager, equipment plant, MicroSemiconductor Corp., Culver City, Calif. Prior to joining MicroSemiconductor, Stillwell was reliability equipment manager for Pacific Semiconductor's *Minuteman* program.

Dr. Peter I. Pollak: Former manager of electronic chemicals, promoted to director of the electronic chemicals research department of the Merck Sharp & Dohme Research Laboratories, a division of Merck & Co., Inc., Rahway, N.J. Other Merck researchers named to the new department are: **Dr. Walter C. Benzing,** manager of process engineering and metallurgy; **John E. Allegretti,** semiconductor technology, **Dr. John B. Conn,** thermoelectrics; and **Dr. William J. McAleer,** semiconductor chemistry.

Edward P. Tagge: General auditor for Beckman Instruments, Inc., Fullerton, Calif., named assistant to the president.

Erich A. Herold: Appointed manager of manufacturing planning at Sanders Associates, Inc., Nashua, N.H. Herold was formerly assistant factory manager with Republic Aviation, Farmingdale, N.Y.

Raymond F. Jacque: Former assistant manager of quality control, named manager of quality assurance in the Military Products Division of General Dynamics/Electronics, Rochester, N.Y.

J. M. Gardiner: Appointed assistant to the president of Thiokol Chemical Corp., Bristol, Pa. **R. E. Davis** succeeds Gardiner as head of Washington, D.C., office; **D. R. Thielen** named manager of Dayton Division office.

Ernest W. Powers: Named director of plans and promotion; **Leslie C. Mackrill** named senior research engineer; and **Michael M. Marks** named senior technical adviser of Frederick Research Corp., Wheaton, Md.

Grayson Merrill: Former manager of Astrionics Division of Fairchild Engine and Airplane Corp., joins Harris-Intertype Corp., Cleveland, as vice president-electronics.

Dr. Donald B. Brick: Named manager of information processing group at the Applied Research Laboratory of Sylvania Electronic Systems, Waltham, Mass. With Sylvania since 1955, Dr. Brick was formerly a research fellow at Harvard University.

Dr. H. Igor Ansoff: Vice president of Lockheed Electronics Co., appointed general manager of the company's Information Technology Division, Metuchen, N.J.

Lt. Col. John R. F. Bond and **Lt. Col. Stanley L. Nyhan:** Appointed executive officer and assistant for personnel, respectively, of Redstone Arsenal.

Dr. Charles F. Lombard: Leading authority on protective equipment for vital stress areas of the human body, joins Northrop Corp.'s Advanced Research Center, Hawthorne, Calif.

Dr. J. Richard Hechtel: Joins Research Laboratory of Litton Industries Electron Tube Division, San Carlos, Calif., as senior scientist. He was formerly head of the microwave tube branch, Naval Ordnance Test Station, China Lake, Calif.

William K. Fortman: Named director of research for the newly-created Astrosonic Development Laboratories of Astrosonics, Inc., Syosset, L.I., N.Y.

Dr. Z. I. Slawsky: Appointed chief of the Physics Research Department at Naval Ordnance Laboratory, White Oak, Md., succeeding **Dr. S. J. Raff,** now with the Bureau of Naval Weapons, Washington, D.C.

Robert B. Anderson: Joins Brown Engineering Co., Huntsville, Ala., as vice president of customer relations. Earlier he was Huntsville representative with the Autonetics Div. of North Amer. Aviation.

Dr. Konstantin Pestrecov: Internationally-known optical scientist and chief of Northrop's Nortronics Division Optical System Group, named a winner of the Talbert Abrams Award for his advanced work in photogrammetry.

Lawrence B. Richardson, Jr.: Former advanced projects engineer for Chance Vought Aeronautics, named director of marketing for Fairchild Aircraft and Missiles Division, Hagerstown, Md.

John E. Holt: Appointed assistant to the vice president-operations, production, of Crucible Steel Co. of America, Pittsburgh.

Ball Bearing Simulator

Development of a research tool by the Sperry Gyroscope Co. will assure speedier and less costly advances in the design and performance of ball bearings.

The ball bearing simulator can precisely reproduce the major characteristics of these critical friction-easing devices simply and cheaply. Sperry has been able to simulate bearing life tests in only one-tenth the time required for a normal run-to-failure checkout.

The device is able to duplicate the performance of any high speed, high temperature, low lubricant bearing, such as those employed in miniaturized gyroscopes, motors or computer memory drums for missiles or space vehicles.

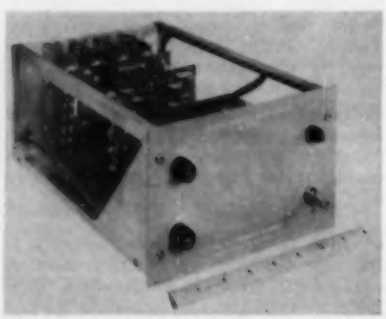
The machine, a table-top device enclosed under a sealed glass cover, exactly simulates such bearing characteristics as operating temperature, atmosphere, ball-to-race contact pressure and surface speed, roll-to-spin ratio and amount and type of ball lubricant.

Circle No. 225 on Subscriber Service Card

Antenna Multicoupler

A completely transistorized wideband antenna multicoupler is available from Trak Electronics Co.

With miniaturized, solid-state, modular construction, the unit operates from 2 to 32 mc in one band and permits simultaneous use of eight receivers from a single antenna. Requiring only 30 watts input power, it has low heat dissipation.



Intermodulation-distortion products are kept low through the use of linear transistor circuitry. Gain is flat over the 2-32 mc band and is constant between channels and units.

Circle No. 226 on Subscriber Service Card

All Glass Diodes

Six high-speed diffused silicon mesa computer diodes (MA-4303 through MA-4308) with all-glass microminiature packaging are available from Microwave Associates, Inc.

All meet the environmental specifications of MIL-S-19500B.

Reliability has been assured by use of a process in which hard glass is fused directly to the junction, eliminating the need for "surface passivation" and providing bonded contacts with no spring.

The diodes are extremely rugged, and combine exceptionally low leakage with very fast switching speeds—typically 2 nanoseconds.

Circle No. 227 on Subscriber Service Card

Low Temp Si Rubber

An extreme low-temperature resistant silicone rubber compound, designed for use in molded and extruded seals and gaskets and a wide variety of mechanical applications, is being marketed by the Silicone Products Dept. of G.E.

Designated SE-5401U, the material is a gray, 40-durometer compound which may be used to meet specifications MIL-R-5847D, Class I, Grade 40 and AMS-3334.

Circle No. 228 on Subscriber Service Card

Power Supply

A transistorized d-c power supply, called Model TR-18-3, has been introduced by the NJE Corp. The unit provides a 50% increase in power (0-18 volts, 0-3 amperes) over the previous design, with no increase in the size of the supply.

The simple addition of an external resistor converts this unit from a constant voltage to a constant current supply.

Electrical specifications include ±0.03% load regulation, 2-millivolt

peak-to-peak ripple, 50 microsecond response time for a full load step, electronic current-limiting for momentary overloads and automatic load removal on sustained overloads. Either positive or negative output terminal may be grounded, or the entire output may be floated 500 volts above or below ground.

Circle No. 229 on Subscriber Service Card

Oxygen Gas Filter

A supplemental vapor-contaminant filter is available from A. Biederman, Inc. for removal of water vapor and other contaminants from air, nitrogen, oxygen and similar gaseous matter in pressure lines. Designed primarily as in-line filter, working in conjunction with the main heavy-duty filter, it provides a positive safeguard against contamination that may develop within the air lines.

The unit is 5 in. long and consists of a reusable desicant filter, encased in a plastic shell, with molded vinyl tubing, 4 in. long on the receiving end and 44 in. long on the other. Both ends are fitted with NPT brass fittings for easy installation. The entire unit weighs only half a pound and is encased in an aluminum shell. Operating pressure is guaranteed safe to 75 psi.

Circle No. 230 on Subscriber Service Card

Lanyard Operated Switch

A four-pole, double-throw switch combining contact design with a plunger and spring operating mechanism for position stability has been developed for missile use by Kinetics Corp.

The Kinetics unit has successfuly passed high-level sinusodial and random-noise vibration tests in both axes in the normally open and closed positions without contact movement or chatter. The highest vibration level the switch has passed to date has been an equivalent 92 g's rms at 2200 cycles.

Testing was carried out at frequencies from 50 to 2000 cps. If required, switches of this design can be built to withstand even greater vibration.

Circle No. 231 on Subscriber Service Card

Heat Transfer System

Eastern Industries is marketing an airborne heat transfer system used to cool electronic countermeasure equipment miniaturized to the point where neither convection nor fan cooling is adequate. Designated E/HT-200-214, the unit has a capacity of 3400 watts, and maintains the ethylene-glycol/water coolant between 150 and 170°F by means of a temperature regulating valve.

This cooling pack is designed for operating temperatures from −55° to 55°C, and performs from sea level to 50,000 ft.

Weighing only 25 lbs., it fits within a compact 4.6 x 10 x 20 in. envelope, and requires a power supply of 208 volts, 3 phase, 400 cycles.

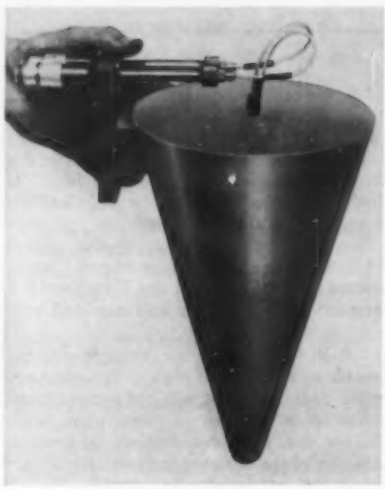
Circle No. 232 on Subscriber Service Card

Broadband Antennas

A line of broadband antennas is available from the Maryland Division of Litton Systems, Inc.

Vertical, horizontal, left-circular, and right-circular polarizations can be provided in bandwidths of 10 to 1 or greater. The beamwidths and gain of these antennas are essentially constant across the entire operating band.

Models now available are model 12E1-10, which covers the frequency range of 100 to 1000 mc with a gain of 8 ±1 db and a maximum VSWR of 2.0 to 1; and model 13E1-5, which covers the range from 1000 to 5000 mc



with a gain of 7 ±1 db and a maximum VSWR of 2.2 to 1.

Also available is a master control unit. This unit, when used with these antennas, provides a single installation covering 100 to 5000 mc.

Circle No. 233 on Subscriber Service Card

Lead Sulfide Photo Cells

A complete line of lead sulfied infrared cells is being marketed by Cetron Electronic Corp.

These subminiature, all-glass, hermetically sealed cells are environmentally stable, with pins for socket mount or flexible leads. The line of cells includes a broad range of stock sizes, broken down into several sensitivity ratings.

Circle No. 234 on Subscriber Service Card

new literature

DRY LUBRICANT—General Magnaplate Corp. has made available a brochure which details the latest results of the use of Hi-T-Lube, a high-temperature dry lubricant. Included in the brochure is full information about Hi-T-Lube together with the new data obtained from exhaustive tests. Hi-T-Lube performed effectively for more than three hours at over 1000°F, where other lubricants and combinations of materials failed in less than five minutes.

Circle No. 200 on Subscriber Service Card

CUTTING TOOLS—The Carborundum Company has published a catalog on Stupalox ceramic cutting tools. It gives the properties data on Stupalox and specs and prices on throw-away inserts, heavy-duty button inserts, solid inserts, unground blanks, single-point tools, and tool holders.

Circle No. 201 on Subscriber Service Card

METAL BELLOWS—An eight-page brochure presenting extensive design and application data concerning welded diaphragm bellows is available from Metal Bellows Corp. It is organized under eight section headings providing a highly concise story of welded-metal diaphragm bellows design and applications. These headings are: Introduction, Basic Diaphragm Contours, Applications for Basic Contours, Illustrations, Definition of Terms, Attaching Bellows, Explanation and Use of Design Curves, and Bellows Materials.

Circle No. 202 on Subscriber Service Card

COPPER-CLAD LAMINATES—Grades XXP-E and XXP-R copper-clad, paper-phenolic laminated plastic, which have excellent punching and machining properties, are described in Technical Data Bulletin No. 3.1.20 published by Taylor Fibre Co. The bulletin gives thickness tolerance of the copper foil, thickness tolerance of copper-clad sheets and the bond strength and heat resistance of the composite sheets.

Circle No. 203 on Subscriber Service Card

CONNECTORS—Details of series 600, 700, 800 circular connectors are described in a two-page illustrated bulletin issued by the Data Recorders Division of Consolidated Electrodynamics Corp. The MS-type connectors are manufactured in accordance with MIL-C-26500 and are designed to meet the stringent environmental requirements of high-performance aircraft, missile, space, and marine vehicle applications.

Circle No. 204 on Subscriber Service Card

SEALED VALVES—A line of hermetically sealed valves for service in pressurized water reactors, and containment of dangerous, toxic radioactive or highly corrosive liquids and gases is described in an 8-page brochure just issued by the Atomic Power Department of United Shoe Machinery Corp. The harmonic drive principle, which permits valve actuation through a completely sealed pressure envelope, is illustrated in two basic forms: rotary input and linear output, and rotary input with rotary output. The application of the principle to globe valves, as well as custom valves and operators is also shown.

Circle No. 205 on Subscriber Service Card

THRUST MEASUREMENT—Technical Bulletin TD-106, released by Gilmore Industries, Inc., describes some typical instrumentation systems for jet-engine test facilities, electronic methods of weight and thrust measurements and calibrations used in ICBM facilities, and an installation at Edwards AFB designed for captive testing of all present and planned aircraft. Also discussed are the various types of secondary standards available for force measurement, as well as the reasons for the decrease in the confidence factor as the secondary standard accuracy approaches the accuracy of the primary standard.

Circle No. 206 on Subscriber Service Card

letters

Man-in-Space Apathy?

To the Editor:

In your editorial "Odd Caution on the New Frontier" (M/R, April 3), the statement—"The implication that *Polaris* is replacing the mobile *Minuteman* will draw no arguments from anyone who has seen what war can do to a railroad"—apparently ignores the real value of a land-based mobile ICBM system. The ICBM mobility concept vastly complicates the problem of single-blow neutralization of our retaliatory forces. The real value is in its war deterrent potential. In any case, destruction of the railroads would not necessarily mean destruction of the mobile ICBM's. These missiles could be transferred overland to existing silos and used to resupply static units, thereby providing an extended counter-blow capability.

The "Odd Caution" regarding the exploitation of "the promising new projects and programs" might better be described as "Gross Neglect." Failure to accelerate our man-in-space (MIS) programs such as *Apollo* and *Dyna-Soar* will surely cause a MIS GAP to occur in the near future. After the "feasibility" of man-in-space is proven in 1961 (the year that the Russians will probably orbit a squad of men) and after the United States orbits a man in 1962, what then?

William E. Howard's article on page 13 of the same issue states that the amount the Air Force would get (in the revised FY '62 budget) to "accelerate the (*Dyna-Soar*) program by 19 months and provide for the first manned flight by mid-1963" is "believed to be less than the $100 million requested." Taking this statement at face value, it seems that during the period 1961-63, no new follow-on manned space operations will occur in the Free World. I wonder if the Russians will stop and wait for us?

It is evident that by the time our big boosters become available for manned space operations, we will not possess man-rated space vehicles to place atop them. Do we really believe that we can match Russian space achievements merely by accelerating our booster programs?

Availability of an operational *Apollo* three-man spacecraft coincident with readiness of the *Saturn C-2* would certainly enhance our position in the space race. Since *Dyna-Soar* flight experience is bound to benefit the *Apollo* program, any delay in *Dyna-Soar* development might have a serious effect on the *Apollo* flight schedule. In any case, if we are not deadly serious about sending men into space, why bother to develop on an accelerated basis such huge boosters and engines as *Saturn C-2* and F-1?

Perpetuation of our apathetic approach to man-in-space could likely result in the absolute denial of our right to explore and ultimately colonize Solar territory. Red domination of our near planets and the moon is a likelihood not to be ignored—so is the posibility of Russian control of near space. Our manned space programs should be given our highest national priority. It is apparent that the Soviet Union placed such emphasis on man-in-space several years ago. If priority is not established, *Prospector's* first great discover as it roams the lunar surface may well be a manned Soviet military base under construction.

Robert H. Jones
Research Engineer
Bellevue, Wash.

Safety Courses

To the Editor:

In the TECHNICAL COUNTDOWN of the Jan. 23 M/R, you reported that the University of Southern Califonia had begun the world's only course in the safe handling of ballistic missiles.

We felt that you would be interested to know that the Customer Training Staff of the Solid Rocket Plant, Aerojet-General Corp., initiated a missile safety and handling course in 1958 for the purpose of training U.S. Navy personnel in the safe handling procedure for the *Polaris*.

Subsequent safety and handling courses have been, and are being conducted for such programs as the *Hawk, Tartar, Skybolt, Genie, Minuteman,* and Aerojet Liquid Propulsion Systems. Safety and and handling is but one course in Aerojet-General's complete curriculum devoted to both solid and liquid-fueled ballistic missiles.

John Z. Ickes
Manager of Public Relations
Sacramento Plants
Aerojet-General Corp.
Sacramento, Calif.

The TECHNICAL COUNTDOWN *item was based on a press release from the university. Presumably, the Southern Cal course is the only one of its kind conducted on a college campus.—Ed.*

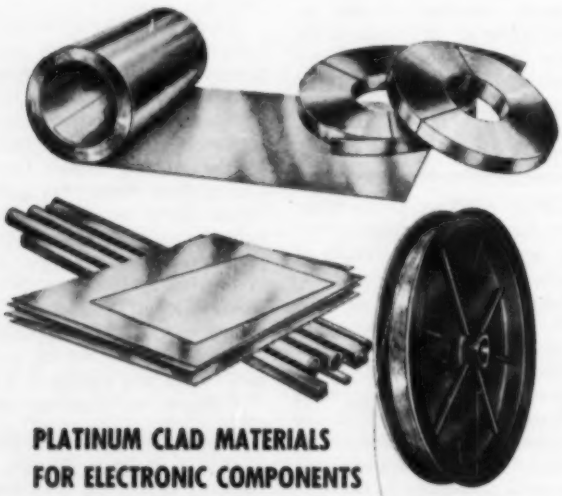
Infernal Digits

To the Editor:

We appreciate very much the reference in M/R, March 27, p. 39, to the ITT Federal Laboratories Electronic Scanning Star Tracker. We note, however, that you refer to a 70-lb. tracker, whereas the actual weight of the unit is 7 lbs.

We would greatly appreciate the printing of a correction concerning the weight of this unit.

H. D. Huffman
Senior Contract Administrator
ITT Federal Laboratories
Fort Wayne, Ind.



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New York 17, N.Y.—20 East 46 Street; YUkon 6-3900
Paul B. Kinney, Eastern Advertising Manager
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Los Angeles, California—8929 Wilshire Blvd.; OLeander 5-9161
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A top expert on Russia tells why the Soviets lead in rocketry — and how we can close the gap now —

RUSSIA'S ROCKETS AND MISSILES

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"An excellent book to study and from which to draw conclusions as to the significance of Soviet scientific progress . . . Although the report is mainly devoted to Russia's achievements and future, you won't find a better or more current review of what we have done and are trying to do."—MAJOR JOHN P. TYLER, in *Army*

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—when and where—

APRIL

Symposium on Structural Dynamics of High Speed Flight (confidential), Aerospace Industries Association and Office of Naval Research, AIA Auditorium, Los Angeles, April 24-26.

Aerospace Medical Association, Thirty-second annual meeting, Chicago, April 24-27.

Ninth Annual Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, April 25-27.

ARS Propellants, Combustion, and Liquid Rockets Conference, American Rocket Society, Palm Beach Biltmore, Palm Beach, Fla., April 26-28.

High Temperature Materials Conference, AIME, Cleveland Section, Pick-Carter Hotel, Cleveland, April 26-27.

18th Annual Western Section Conference of The Society of the Plastics Industry, Hotel del Coronado, Coronado, Calif., April 26-28.

Seventh Region of the Institute of Radio Engineers, 1961 Conference, Hotel Westward Ho, Phoenix, April 26-28.

British Interplanetary Society, Symposium on Liquid Hydrogen as a Rocket Propellant, Royal Aeronautical Society, London, April 28.

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editorial . . .

How We Won the Telegram Race

IT IS HEARTENING to note that President Kennedy has sent Premier Khrushchev a large telegram congratulating the Soviet Union on its achievement in putting the first man into orbit.

We had, in fact, become rather concerned about this vital aspect of the space race. To fall behind in the production of telegraph blanks could do us irreparable harm from a prestige standpoint. To be unable to match a successful Soviet-manned lunar landing with the launching of a massive congratulatory telegram would result in a propaganda defeat of a size to dishearten even Edward R. Murrow.

You will be relieved to learn that the White House has a good supply of large telegraph blanks. This fact emerges from an intensive investigation we have conducted into the U. S. telegraph blank program. Despite some initial setbacks, we find it is moving along at an encouraging step-by-step pace toward objectives which may soon be defined.

We thought you might be interested in the chronology of the U.S. blistering missive program:

1944—German scientists at the Grosser Telegramerwerke achieved considerable early success in the dispatch of telegrams to London although some fell in Geneva and at least one was detected as far away as a railway post office in Cairo, Egypt. An RAF aircraft made a hazardous night landing and returned this telegram to England. After patching it together, British technicians determined that it contained birthday greetings to someone named Helga. RAF and USAF reconnaissance aircraft were immediately assigned to missions to determine the point of origin, since two shillings sixpence were due on the message.

1945—Russian and American intelligence agents descended en masse upon the Grosser Telegramerwerke in an effort to recruit German scientists and technicians with experience in the Nazi program. Although the Soviets succeeded in obtaining the bulk of personnel for their central telegraph office, largely by offering special rates to members of the immediate family, U.S. officials spirited the cream of the crop off to the U.S., where they were assigned to a special project office at Western Union.

1953—The research and development program for Soviet telegraph blank production was moving along at a brisk pace when a breakthrough took place which resulted in a complete re-evaluation of the program. Members of the Soviet Alphabetique Experimentale Cyrillic (AEC) found it was possible to use much smaller cyrillic letters than previously anticipated. This discovery led to a decision to decrease the size of Russian telegraph blanks.

The U.S., meanwhile, having fallen far behind in the field of alphabet miniaturization, was forced into production of gross, unsophisticated telegraph blanks. These consisted of poorly lettered blanks with extremely large spaces for messages.

1957—The U.S. succeeded in sending a telegram all the way around the world with one of its large telegraph blanks. This was hailed as a tremendous propaganda triumph everywhere on the globe. Except in the Soviet Union. Anastas Mikoyan described the blank as a "mere spitball." Premier Khrushchev explained to the Party Congress that smaller Soviet blanks, while unable to carry as many letters, were much less expensive and less of a drain on Soviet taxpayers. Nevertheless, he revealed, an all-out effort was to be made to catch up in the telegraph blank race. No money was to be spent on this.

1959—The U.S. had by this time sent several lengthy telegrams around the world on its unsophisticated blanks. Premier Khrushchev explained in a telecast from Moscow that the Soviet Union has sent a far greater number of small telegrams of two words each. Although admitting it was difficult to say much in only two words, Mr. Khrushchev pointed out the successful miniaturization of the cyrillic alphabet which made this volume of messages possible. He held up one or two letters for the audience to see.

1961—Premier Khrushchev promised the Soviet people an all-out effort to catch the United States in the telegraph blank race. Several approaches were being studied, he said, and as soon as one appeared sufficiently promising some money would be spent. Meanwhile, he revealed, a large telegraph blank was being assembled in the southern province of Azerbaijan. This would be ready to send in 1965, although it was not yet determined what the message should say.

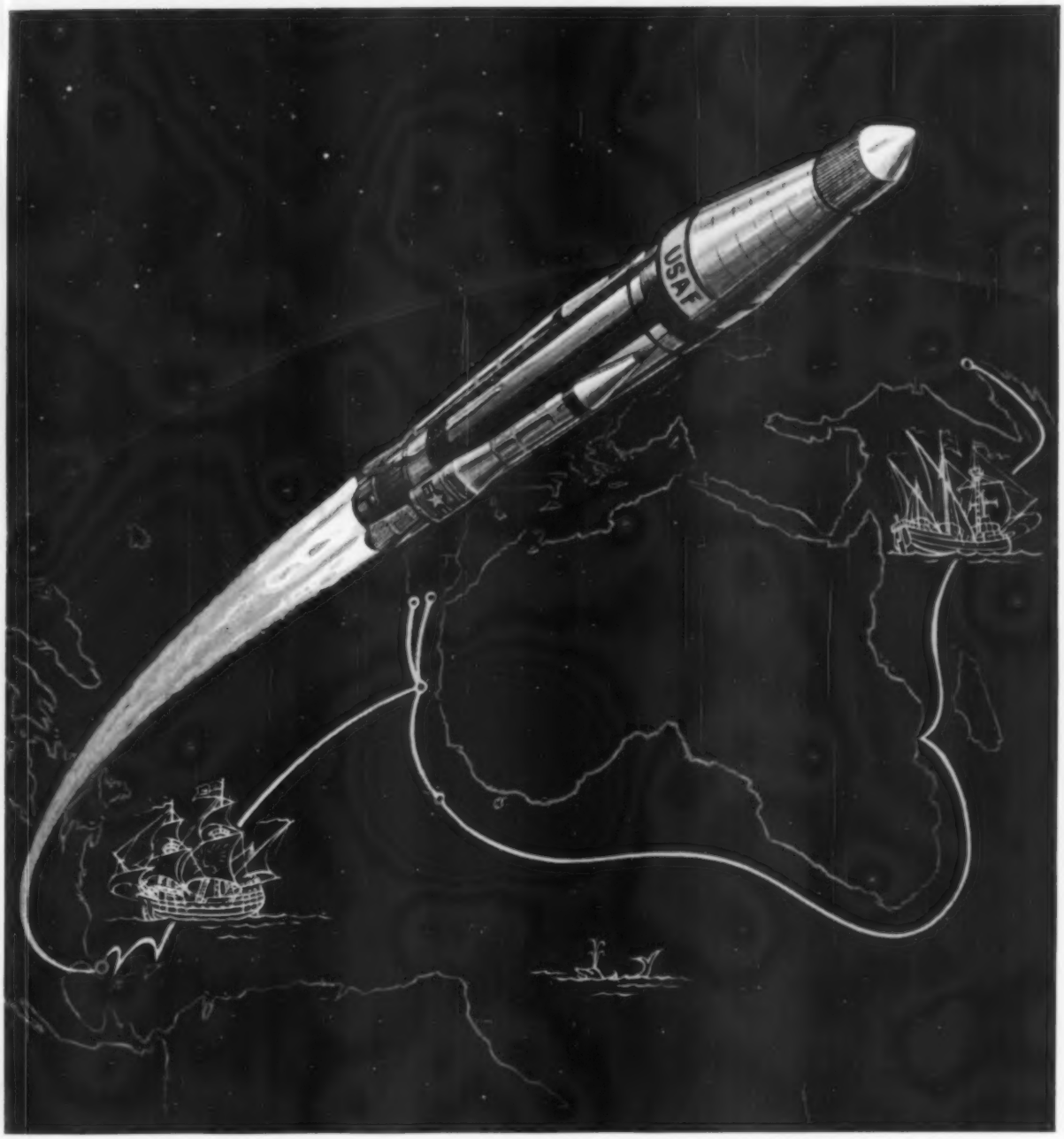
Several members of the Party Congress objected to this program, questioning whether there was any need at all for telegraph blanks. Smoke signals had served very well for years, they pointed out.

EARLY IN THE YEAR, Premier Khrushchev was forced to admit to Yuri Gagarin, a Soviet citizen who had just returned from space, that the United States had sent the most massive telegram to date.

At the same time, the U.S. announced its intention of sending a telegram to the moon. Premier Khrushchev promised an all-out effort to match this feat, although the program was not to be a crash program and no money would be spent.

A disheartened Yuri Gagarin conceded that the most he could hope for was to be on the moon to receive the U.S. telegram.

William J. Coughlin



Arma navigates new routes

Navigating with cross-staff and primitive compass, Prince Henry's Portuguese pilots took more than 80 years to find a route around Africa and reach India. The Spaniards took another 20 years to cross the Atlantic and reach the shores of Florida.

Today, missile-borne inertial guidance can navigate such distances in a matter of minutes and pin-point targets nearly half-way around the world. Other advantages of inertial navigation are immunity to outside interference, all-weather capability, salvo firing, and a minimum of ground equipment.

Arma, designer of America's first inertial guidance of intercontinental range accuracy, has these systems in full production with on-schedule deliveries. Although specified for the Atlas missile, the Arma system is equally adaptable to other aerospace programs and space exploration projects.

At Arma, research programs currently are exploring smaller, supersensitive devices for future generations of missile and space guidance systems. Arma, a division of American Bosch Arma Corporation, Garden City, New York. . . . The future is our business. 0321

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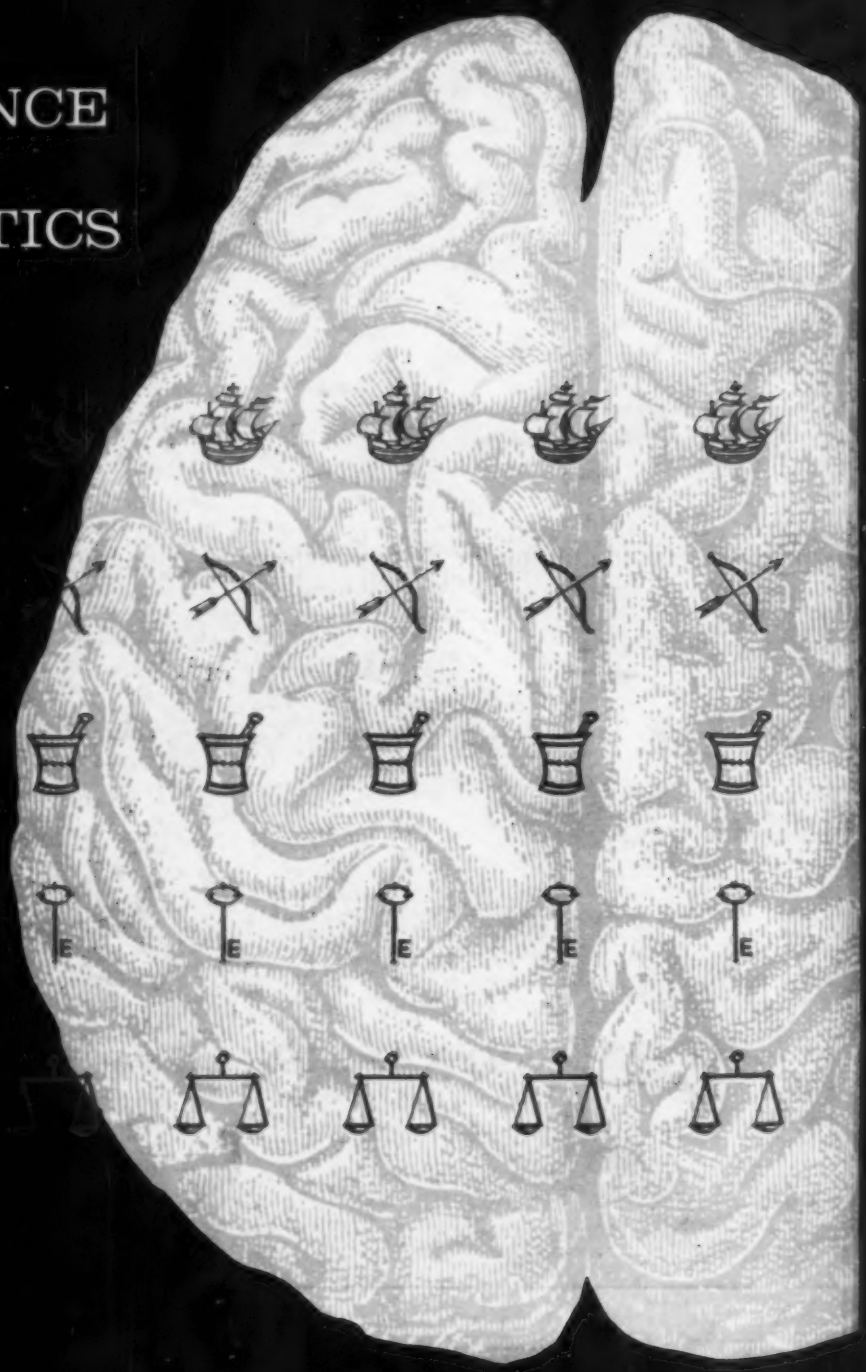
1961

EXPERIENCE IN CYBERNETICS



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